

A REVIEW OF THE IXODID TICKS (ACARI, IXODIDAE) OCCURRING IN SOUTHERN AFRICA

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ABSTRACT

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Eighty-three species of ixodid ticks, as well as several entities that have yet to be described, occur in the Republic of South Africa plus the 4 independent states lying within its borders (Bophuthatswana, Venda, Transkei and Ciskei) and in Namibia, Botswana, Lesotho and Swaziland. They belong to the following genera: *Amblyomma* (8 spp.); *Aponomma* (3 spp.); *Boophilus* (2 spp.); *Cosmiomma* (1 sp.); *Dermacentor* (1 sp.); *Haemaphysalis* (10 spp.); *Hyalomma* (2 spp., one of them with 2 subspp.); *Ixodes* (25 spp.); *Margaropus* (1 sp.); *Rhipicentor* (2 spp.), and *Rhipicephalus* (28 spp.).

The history of tick research in this region is reviewed briefly and advances made by the major contributors to our knowledge are highlighted.

Short comments on each genus are given. These are followed by information on every species known to occur in the region, presented under the following headings: Species diagnosis, under which references to relevant descriptions are listed and, where appropriate, notes on commonly used synonyms, related species and identification problems are included; hosts, indicating whenever possible the preferences of both the adults and the immature stages, as well as differentiating between common and incidental hosts, and distribution in terms of political (not ecological) divisions.

INTRODUCTION

Historical background

Descriptions of ticks that occur in South Africa began to appear in the literature over 200 years ago. In 1778 Baron C. de Geer described 2 species: "*Acarus sylvaticus*", based on a ♀ tick taken from a "Schildkröte" (i.e. a tortoise) at the Cape of Good Hope by Sparrmann, and "*Acarus rhinocerotis*" from a rhinoceros, also at the Cape of Good Hope. Over the years there has been much confusion and controversy about the entities to which his names apply. The current view is that they are the valid names for *Amblyomma sylvaticum* and *Amblyomma rhinocerotis* respectively (Theiler, 1943a; Hoogstraal, 1956).

During the following 66 years another 8 South African ticks were described. Most were common, well-known species, for example *Rhipicephalus sanguineus* (Latreille, 1806) and *Haemaphysalis leachi* (Audouin, 1827), but one, *Cosmiomma hippopotamensis* (Denny, 1843), has rarely been found since it was first discovered.

In 1844 C. L. Koch published his historic work on ticks from different parts of the world in which he laid a large part of the foundation of modern tick systematics, including establishing 5 genera. Eleven ixodids that occur in southern Africa feature in this work, amongst them such important species as *Amblyomma hebraeum*, *Boophilus decoloratus* (as *Rhipicephalus decoloratus*), *Hyalomma marginatum rufipes* (as *H. rufipes*), *Hyalomma truncatum*, *Ixodes pilosus*, *Rhipicephalus capensis* and *Rhipicephalus simus* (Theiler, 1962).

In terms of the number of new tick species he described Koch's contribution to our knowledge has been exceeded only by that of the great French parasitologist L. G. Neumann, of the Veterinary School at Toulouse, in southern France. His interest in South African ticks was stimulated through his close and cordial association with C. P. Lounsbury, who emigrated from the United States of America to take up an appointment as Government Entomologist to the Department of Agriculture, Cape of Good Hope, in 1895. Initially Lounsbury worked on the

insect pests of crops and orchards, then in 1898 he began the detailed, painstaking observations on ticks and tickborne diseases for which he became famous. In 1899 he wrote to Neumann and began sending him specimens. In 1901 Neumann published a description of *Rhipicephalus appendiculatus*, followed in 1904 by descriptions of *Rhipicephalus nitens* and *Ixodes rubicundus*, based on some of Lounsbury's collections. Besides these 3 species Neumann described another 16 that occur in South Africa from specimens obtained from various sources in other parts of the continent.

Lounsbury also sent many ticks, including live specimens for experimental purposes, to G. H. F. Nuttall in England (Keirans, 1985). Nuttall and his Cambridge colleague, C. Warburton, with their collaborators W. F. Cooper and L. E. Robinson of the Cooper organization, made considerable contributions to the systematics of African ticks. Between them they described 9 species that occur in southern Africa, among them *Haemaphysalis silacea* and the genus *Rhipicentor* with its 2 species *R. bicornis* and *R. nuttalli*. Many of their findings were included in books on the Argasidae and on the genera *Ixodes*, *Haemaphysalis* and *Amblyomma*, published under the general title "Ticks—A monograph of the Ixodoidea" (Nuttall, Warburton, Cooper & Robinson, 1908–1926), that remain essential references to this day.

Another renowned tick systematist during the early part of this century was W. Dönitz of Berlin, to whom many tick collections from "Deutsch-Südwest-afrika" (Namibia) and "Deutsch-Ostafrika" (Tanzania) were sent. He published a number of valuable papers on his findings, of which those on the genus *Amblyomma* (Dönitz, 1909) and on various southern African species (Dönitz, 1910) are especially relevant. Subsequently the ticks of Namibia also received attention from Trommsdorff (1914) and Hans Sigwart (1915).

The first overall review of southern African ticks was published in 1908 by C. W. Howard who, like Lounsbury, had emigrated from the United States. It was a particularly remarkable achievement because he was appointed as Assistant Entomologist, Transvaal Department of Agriculture, only in 1905 and by 1908 had moved to Portuguese East Africa (Mozambique).

In February 1912 G. A. H. Bedford arrived from England to take up a post as Entomologist at Onderstepoort, where he worked for 26 years. Referred to later by Theiler (1975) as "a taxonomist *par excellence*", he studied virtually all the parasitic arthropods occurring in South Africa. These included ticks, of which he described 3 new species (*Haemaphysalis cooleyi*, *Ixodes elongatus* and *Rhipicephalus theileri*). In 1932 he published a valuable checklist and host list of the ectoparasites found on South African reptiles, birds and mammals, to which he later added a supplement (Bedford, 1932, 1936). He also began what was obviously intended to be a series of papers on South African ticks, of which only the first part was published (Bedford, 1934).

Following Bedford's early death in 1938 R. du Toit assumed responsibility for work on ticks, and in 1941 described *Rhipicephalus glabroscutatum*. His involvement with these parasites was relatively brief because Gertrud Theiler was appointed at Onderstepoort in 1940 and immediately took over the basic tick research. She undertook this task with enthusiasm and during the following quarter of a century carried out numerous fundamental studies on the systematics of African ticks, assisted for short periods by Britha Robinson and Lois Salisbury. She maintained close and cordial links with other tick workers worldwide and became the doyenne of those in Africa. Her studies culminated in her review of all the known tick species occurring in the Afro-tropical region (Theiler, 1962). Finally in 1975 she published an interesting synopsis of tick research in Africa which amplifies this brief account. Further details regarding the contributions made by many other people to our current knowledge of southern African ticks, for example H. Hoogstraal, D. R. Arthur, F. Zumpt and J. A. T. Santos Dias, will also be found later in the present paper under the accounts of individual genera and species.

Scope of this review

All the genera and species of ixodid ticks presently recognized in southern Africa are included. Short comments on each genus are followed by information on the individual species presented under the subheadings species diagnosis, hosts, and distribution.

The sections on species diagnosis include references to descriptions plus notes on commonly used synonyms, related species and taxonomic problems. In these sections the term "undescribed" indicates that the stage(s) referred to have been identified but not as yet formally described, whereas "unknown" indicates that they have not even been recognized.

The sections on hosts include, whenever possible, information on the preferences of both the adults and the immature stages. Their preferred and incidental hosts are also differentiated. Host nomenclature is according to that given in the following publications: reptiles—Broadley (1983), Patterson & Bannister (1987), Boycott & Bourquin (1988); birds—Maclean (1985), and mammals—Meester, Rautenbach, Dippenaar & Baker (1986).

The information on distribution is given primarily according to political, not ecological, divisions. As used here the term "southern Africa" implies the Republic of South Africa and the 4 independent states lying within its borders (Bophuthatswana, Venda, Transkei and Ciskei), plus Namibia, Botswana and Swaziland. Some records from Lesotho are also included, though no formal tick survey has ever been carried out there and few data are

available.

The transmission of human and animal pathogens by the ixodid tick species reviewed here is mentioned under the various genera, but only briefly. References on this subject have been kept to a minimum. In particular those cited by Neitz (1956) in his comprehensive review of this subject have been omitted.

GENUS *AMBLYOMMA* KOCH, 1844

Generic characteristics:

- (a) Ornate, i.e. a coloured pattern is usually present on the scutum
- (b) Legs banded
- (c) Hypostome and palps long
- (d) Eyes present
- (e) Festoons present
- (f) Adanal plates in the male absent

This genus, the third largest in the family Ixodidae, is distributed world-wide. The majority of these bont ticks, which are mostly large, colourful species, feature in a monograph by Robinson (1926). This work remains a basic reference even today for most African members of the genus.

Eight species of *Amblyomma* occur in southern Africa. These fall into 2 groups: 4 species whose known hosts are primarily mammals (*hebraeum*, *rhinocerosinus*, *tholloni* and *variegatum*) and 4 that are basically, but not always exclusively, parasites of reptiles (*marmoreum*, *nuttalli*, *sparsum* and *sylvaticum*). The latter group was reviewed in detail in a paper by Theiler & Salisbury (1959) that supersedes the earlier findings on some of these ticks by Robinson (1926).

Economically *A. hebraeum* and *A. variegatum* are 2 of the most important tick parasites of livestock in Africa, mainly because they are the principal vectors of *Cowdria ruminantium*, the causative agent of heartwater in cattle, sheep and goats. The ecology of these ticks, and of other *Amblyomma* spp. that can transmit *C. ruminantium*, was recently reviewed by Petney, Horak & Rechav (1987). In East Africa *A. variegatum* is also a vector of Nairobi sheep disease virus. Both *A. hebraeum* and *A. variegatum* can transmit *Rickettsia conori*, which causes human tick-bite fever (tick-borne typhus).

Adult bont ticks, and sometimes their nymphae, inflict severe bites on animals. These bites result in discomfort and extensive tissue damage, especially to the udders and teats of cows and to hides and skins in general. Often such bites act as routes of infection for various pathogenic organisms (Yeoman & Walker, 1967). For example, the bites of numerous *A. hebraeum* adults and nymphae round the hooves of goats caused skin damage and abscessation resulting in lameness (MacIvor & Horak, 1984, 1987).

Amblyomma hebraeum Koch, 1844

Species diagnosis: Robinson (1926), Arthur (1973), Walker & Olwage (1987).

Hosts: Cattle are regarded as the primary domestic hosts of the adults. They also feed readily on sheep, goats, horses and other equines, and sometimes on pigs and dogs. In addition adults have been collected from many species of wild mammals, especially the larger ungulates (Theiler, 1962; Petney *et al.*, 1987). Larvae and nymphae often feed on the same hosts as the adults. They also parasitize

many smaller animals, among them various carnivores (Carnivora, Canidae, Viverridae and Felidae) and hares, especially the scrub hare (*Lepus saxatilis*) (Lagomorpha, Leporidae) (Horak, MacIvor, Petney & De Vos, 1987b; Horak, Jacot Guillarmod, Moolman & De Vos, 1987c). Birds are important hosts of the immature stages, especially ground-feeding species such as the helmeted guinea fowl, *Numida meleagris* (Galliformes) (Theiler, 1962; Horak & Williams, 1986). Sometimes the leopard tortoise, *Geochelone pardalis* (Reptilia, Testudinae) harbours quite large numbers of nymphae (Walker & Schulz, 1984).

Distribution: In South Africa *A. hebraeum* occurs in the Transvaal bushveld; much of Swaziland; most of the thornveld and coastal areas of KwaZulu, Natal and the Transkei; in the coastal areas of the eastern Cape Province as far as Humansdorp, and in the Mossel Bay area (Theiler, 1948). Since Theiler's original survey the bont tick has apparently spread in both Swaziland and Natal (Baker & Ducasse, 1967; Howell, Walker & Nevill, 1978; Jagger, Wedderburn & McCartan, 1987; Walker & Olwage, 1987). In Botswana *A. hebraeum* is widespread in North-eastern and Kgatlang Districts and in the eastern parts of Central, Kweneng and Southern Districts. Paine (1982) commented that the bont tick was believed locally to have spread during the previous decade. He had collected a single ♂ in Ghanzi District but did not know whether the tick was actually established there. Extralimitally *A. hebraeum* occurs in Zimbabwe and southern Mozambique.

***Amblyomma marmoreum* Koch, 1844**

Species diagnosis: Theiler & Salisbury (1959); Arthur (1975a, b); Walker & Olwage (1987). This species was confused with *A. sparsum*, and sometimes with *A. nuttalli*, by Robinson (1926).

Hosts: All stages feed on reptiles, most commonly tortoises (Chelonia, Testudinidae) but also some of the larger snakes, especially the puff adder, *Bitis arietans*, varanids and other lizards (Squamata) (Theiler, 1962; Walker & Schulz, 1984). Unlike the adults, which are specific parasites of reptiles (Hoogstraal & Aeschlimann, 1982), the immature stages, especially the larvae, also feed on a wide range of other animals. They have been collected from cattle, sheep, goats and dogs; various carnivores (Canidae, Viverridae and Felidae), especially black-backed jackals, *Canis mesomelas*, and caracals, *Felis caracal*; a few ungulates (Artiodactyla, Bovidae), the scrub hare, *Lepus saxatilis*, and Smith's red hare, *Pronolagus rupestris* (Lagomorpha, Leporidae) (Norval, 1975b; Horak & Knight, 1986; Horak, Potgieter, Walker, De Vos & Boomker, 1983b; Horak *et al.*, 1987 b, c). Various ground-feeding birds have also been recorded as hosts, particularly the helmeted guineafowl, *Numida meleagris* (Galliformes) (Norval, 1975b; Horak & Williams, 1986).

Distribution: In South Africa *A. marmoreum* is widely distributed (Theiler & Salisbury, 1959; Walker & Olwage, 1987). In Namibia, though, there are as yet scattered records only, from Outjo, Okahandja, Windhoek and Gobabis, and from Karasburg District (Theiler & Salisbury, 1959; Heloise Heyne, unpublished data). In Botswana it has been collected on Chief's Island in the Okavango; 100 km east of Maun on the Francistown road, and at Tshesebe and Serowe (Theiler & Salisbury, 1959; Walker, Mehrlitz & Jones, 1978; Paine, 1982). Extralimitally it occurs in Zimbabwe and southern Mozambique.

***Amblyomma nuttalli* Dönitz, 1909**

Species diagnosis: Theiler & Salisbury (1959), Arthur (1975a, b). This tick was sometimes confused with *A. marmoreum* by Robinson (1926).

Hosts: All stages feed on reptiles. The most commonly recorded hosts are tortoises, including the hinged tortoise, *Kinixys belliana*, and the leopard tortoise, *Geochelone pardalis* (Chelonia, Testudinidae). Leguaans (*Varanus* spp.) are also favoured, as are some of the larger snakes such as the python (*Python sebae*), puff adder (*Bitis arietans*) and gaboon viper (*Bitis gabonica*) (Squamata, Varanidae, Boidae and Viperidae). Theiler & Salisbury (1959) and Theiler (1962) also list various birds and mammals as hosts, often of the immature stages only, but their significance in the maintenance of this species has yet to be established.

Distribution: In South Africa *A. nuttalli* is commonest in KwaZulu and Natal. It has also been recorded in the Transvaal at Onderstepoort; in the north-eastern Cape Province at Kuruman, and in the eastern Cape Province at Grahamstown. It is widely distributed extralimitally in the Afrotropical region.

***Amblyomma rhinocerotis* (De Geer, 1778)**

Species diagnosis: Robinson (1926, as *Amblyomma petersi*), Hoogstraal (1956). Immature stages unknown.

Hosts: Adults feed primarily on the white and the black rhinoceros, *Ceratotherium simum* and *Diceros bicornis* (Perissodactyla, Rhinocerotidae). It has only occasionally been collected from other animals (Hoogstraal, 1956; Yeoman & Walker, 1967).

Distribution: In South Africa this species has been recorded in northern KwaZulu and Natal in Ndumu, Mkuze, Hluhluwe and Umfolozi Game Reserves plus the Corridor area between the latter 2 reserves (Baker & Keep, 1970). Theiler (1962) also lists an old record from the eastern Cape Province in "Kaffraria". Extralimitally it has been widely recorded in East and Central Africa.

***Amblyomma sparsum* Neumann, 1899**

Species diagnosis: Theiler & Salisbury (1959), Walker & Olwage (1987). Prior to the definitive study of the *Amblyomma marmoreum* group by Theiler & Salisbury this tick was frequently misidentified as *A. marmoreum*.

Hosts: Adults of *A. sparsum* favour 2 distinct groups of animals as hosts—some of the larger species of wild mammals on the one hand and various reptiles on the other. Their commonest mammalian hosts are the black rhinoceros, *Diceros bicornis* (Perissodactyla, Rhinocerotidae) and the buffalo, *Syncerus caffer* (Artiodactyla, Bovidae). They have also been collected from various other wild mammals, mostly the larger species, but such records are comparatively rare. Amongst reptiles, tortoises are most commonly parasitized, including specifically the hinged tortoise, *Kinixys belliana*, and the leopard tortoise, *Geochelone pardalis* (Chelonia, Testudinidae). Water and rock leguaans (*Varanus niloticus* and *Varanus exanthematicus*), agamid lizards (*Agama* spp.), pythons (*Python sebae*) and puff adders (*Bitis arietans*) (Squamata, Varanidae, Agamidae, Boidae and Viperidae) may also be infested (Theiler, 1962; Yeoman & Walker, 1967; Walker, 1974; Petney *et al.*, 1987).

Distribution: Thus far *A. sparsum* has been found in southern Africa only in northern Namibia. One ♀ was recorded in Outjo District (Heloise Heyne, un-

published data) and a ♂ was collected in 1933 by the Government Veterinary Officer, Grootfontein (Theiler & Salisbury, 1959). Extraliminally it is widely distributed in the Afrotropical region, especially in eastern and central Africa.

***Amblyomma sylvaticum* (De Geer, 1778)**

Species diagnosis: Theiler (1943a).

Hosts: Reptiles. All stages parasitize tortoises, especially the angulate tortoise, *Chersina angulata*, also the common padloper, *Homopus areolatus*, and the tent tortoise, *Psammobates tentorius* (Chelonia, Testudinidae). The immature stages only have been collected from the spiny agama, *Agama hispida*, and Knox's desert lizard, *Meroles knoxi* (Squamata, Agamidae, Lacertidae), and adults plus nymphae from the mole snake, *Pseudaspis cana* (Squamata, Colubridae).

Distribution: This species is known only from South Africa, Cape Province, where it has been recorded in the coastal areas from Port Elizabeth westwards to the Cape peninsula and up the west Cape coast as far as Hondeklip Bay. It may well occur throughout the range of the angulate tortoise (Boycott & Bourquin, 1988). Warburton (1927) also lists 3 collections of *A. sylvaticum* (syn. *Amblyomma latum* Koch, 1884) in the Vienna Museum from "Natal" and "Cape Zelabor". As Theiler (1962) pointed out, these collections should be restudied; this tick has not been recorded in Natal in recent times and the whereabouts of Cape Zelabor is unknown.

***Amblyomma tholloni* Neumann, 1899**

Species diagnosis: Robinson (1926), Hoogstraal (1956), Van der Borgh-Elbl (1977), Walker & Olwage (1987).

Hosts: This species occurs primarily on the elephant, *Loxodonta africana* (Proboscidea, Elephantidae), from which adults, and sometimes nymphae, have often been collected. If cattle, sheep and goats are kept in areas inhabited by elephants they too may be parasitized by the immature stages of this tick (MacKenzie & Norval, 1980). Various reptiles, birds and other wild mammals have also been listed as hosts (Theiler, 1962; Petney *et al.*, 1987) but they are probably of secondary importance in its maintenance.

Distribution: *A. tholloni* is restricted to areas in which elephants occur. In South Africa it has been recorded in the Transvaal, in Sibasa and the Kruger National Park, and KwaZulu, in Ndumu Game Reserve and Tongaland. Extraliminally it is very widely distributed in the Afrotropical region.

***Amblyomma variegatum* (Fabricius, 1794)**

Species diagnosis: Hoogstraal (1956), Van der Borgh-Elbl (1977), Walker & Olwage (1987).

Hosts: All stages feed on cattle, which are major hosts of this species. Sheep, goats and other domestic animals are infested to a lesser extent (Petney *et al.*, 1987). On wild animals adults are most prevalent on medium-sized to large herbivores. Many species of the order Artiodactyla, in particular, have been recorded as hosts. Herbivores belonging to other orders are much less commonly parasitized by this tick. The immature stages have been found on a few reptiles, various species of birds and many different mammals (Theiler, 1962; Petney *et al.*, 1987).

Distribution: In Namibia *A. variegatum* occurs

throughout the eastern Caprivi Strip (Theiler, 1962). In the neighbouring parts of northern Botswana it has been found in Ngamiland in the Kwando River area, also in Chobe District at Kavimba, Kazungulu (Kazungula), Leshomo (Lesomo) and Pandamatenga (Paine, 1982). Extraliminally it is the most widely distributed of the Afrotropical *Amblyomma* species. It has also extended its range considerably outside Africa, eastwards to the Yemen Arab Republic, Madagascar and various islands in the Indian Ocean, and westwards to the Cape Verde islands and islands in the eastern Caribbean (Walker & Olwage, 1987).

GENUS *APONOMMA* NEUMANN, 1899

Generic characteristics:

- (a) Hypostome and palps long
- (b) Eyes absent
- (c) Festoons present
- (d) Adanal plates in the male absent

This genus of small, eyeless ticks, almost all of which are parasites of snakes and/or varanid lizards (leguaans or monitors) (Hoogstraal & Aeschlimann, 1982), was revised by Kaufman (1972). Subsequently Santos Dias (1985) has disagreed with Kaufman's findings regarding the synonymy of some species.

Three *Aponomma* species occur in southern Africa. One (*exornatum*) is ornate while the other 2 (*latum* and *transversale*) are inornate.

***Aponomma exornatum* (Koch, 1844)**

Species diagnosis: Theiler (1945a), Kaufman (1972).

Hosts: Primarily the water and rock leguaans *Varanus niloticus* and *V. exanthematicus* (Squamata, Varanidae). The adults often attach in the leguaan's nasal passages and sometimes even suffocate captive specimens (Young, 1965). Theiler (1962) also lists this tick from a wide range of other animals, including different reptiles, a bird, and various mammals, but these are thought to be incidental hosts only.

Distribution: In South Africa *A. exornatum* is very widely distributed. In Namibia it is recorded in Etosha Game Reserve and at various places in Grootfontein, Omaruru and Windhoek Districts, and in Botswana in Ngamiland and at Kanye. It is probably present throughout the range of its varanid hosts. Apart from the Namib Desert and the southwestern Cape Province *V. exanthematicus* occurs throughout southern Africa, while *V. niloticus* is found along the east flowing rivers, in the Okavango Swamps, and in the lower reaches of the Kunene and Orange Rivers (Patterson & Bannister, 1987). Extraliminally *A. exornatum* is widely distributed in East and parts of Central Africa.

***Aponomma latum* (Koch, 1844)**

Species diagnosis: Theiler (1945b), Kaufman (1972).

Hosts: Many species of snakes (Squamata, sub-order Ophidia), especially the larger ones (Theiler, 1962; Kaufman, 1972). The occasional records that these authors list from various lizards, and even from a few mammals, are thought to represent incidental infestations only.

Distribution: It is widely distributed in South Africa, but in Namibia has as yet been recorded only at Okahandja and Gobabis, and in Botswana on Xhaga Island (not located, but presumably in the

Okavango swamps). Extraliminally it is very widely distributed in the Afrotropical region.

***Aponomma transversale* (Lucas, 1845)**

Species diagnosis: Theiler (1945b), Kaufman (1972). Larva unknown.

Hosts: Pythons (Squamata, Boidae), of which *Python sebae*, the African python, is the only host species recorded in southern Africa so far.

Distribution: In South Africa 4 collections only have been recorded, of which 2 were from captive pythons in the Johannesburg Zoo and the Cape Town Snake Park. It has also been collected in the eastern Transvaal lowveld, in the Manyeleti Game Reserve (Heloise Heyne, unpublished data), and in Natal at Pietermaritzburg. The true range of this tick probably coincides with that of the African python, which in South Africa occurs in parts of the Transvaal, Swaziland, KwaZulu, Natal, and the north-eastern and eastern Cape Province, also in northern Namibia and in parts of Botswana (Broadley, 1983). The paucity of records of this tick possibly reflects collectors' lack of opportunity, and perhaps enthusiasm, to examine its apparent predilection site on these large, somewhat unmanageable and irascible snakes, their eyelids. Extraliminally it is widely, though discontinuously, recorded in the Afrotropical region.

GENUS *BOOPHILUS* CURTICE, 1891

Generic characteristics:

- (a) Inornate
- (b) Hypostome and palps short
- (c) Eyes present, though they are sometimes difficult to see
- (d) Festoons absent
- (e) Adanal plates in the male present

Members of this small, but economically important, genus are commonly known as blue ticks. They are widely distributed in the Afrotropical and Oriental regions, Australia and the New World. Two species only have been recorded in southern Africa.

In a series of papers published during the 1930s W. Minning divided the genus into 3 subgenera, *Boophilus sensu stricto*, *Uroboophilus* and *Palpoboophilus*, and described several new species. His classification was initially accepted, and some of the names he proposed appear in the South African literature, but it is not now regarded as valid (Hoogstraal, 1956).

The boophilids are one-host ticks. They are important both as vectors of various pathogens and also because they have over the years developed resistance to a wide range of acaricides. The common blue tick, *Boophilus decoloratus*, is the species that is most frequently implicated in the transmission of 3 cattle parasites: *Babesia bigemina*, causing African redwater, also *Anaplasma marginale* and *A. centrale*, causing gallsickness. The pantropical blue tick, *Boophilus microplus*, is a vector not only of *B. bigemina* but also of *Babesia bovis*, causing Asiatic redwater, and of *A. marginale*. In addition both these ticks can transmit *Borrelia theileri*, the cause of spirochaetosis in various domestic animals.

***Boophilus decoloratus* (Koch, 1844)**

Species diagnosis: Hoogstraal (1956), Arthur & Londt (1973), Heyne (1986). It was referred to as *Boophilus (Palpoboophilus) decoloratus* by Theiler (1949b).

Hosts: The blue tick is primarily a parasite of the larger domestic and wild ungulates (Artiodactyla, Bovidae, Perissodactyla and Equidae) (Theiler, 1962). Cattle are its main domestic hosts, and very heavy infestations may also develop on horses (Theiler, 1911; Hoogstraal, 1956). Other domestic animals appear to be much less important as hosts (Hoogstraal, 1956; Baker & Ducasse, 1968). In the Kruger National Park it occurs in large numbers on Burchell's zebra, *Equus burchellii* (Horak, De Vos & De Klerk, 1984a), and was the most abundant and most prevalent tick recorded on blue wildebeest, *Connochaetes taurinus* (Horak, De Vos & Brown, 1983c). Numerous blue ticks have also been found on giraffe, *Giraffa camelopardalis*; kudu, nyala and bushbuck, *Tragelaphus strepsiceros*, *T. angasii* and *T. scriptus* respectively, and eland, *Taurotragus oryx* (Horak *et al.*, 1983b), as well as impala, *Aepyceros melampus*. The few species of birds, carnivores and lagomorphs listed as hosts by Theiler (1962) are not thought to be of any significance in the maintenance of this tick.

Distribution: In South Africa *B. decoloratus* is widely distributed in the Transvaal, Swaziland, KwaZulu and Natal, the northern and eastern Orange Free State, north-eastern and eastern Cape Province, in the southern coastal belt and in the winter rainfall areas of the western Cape Province (Theiler, 1949b; Howell *et al.*, 1978; Jagger *et al.*, 1987). In Namibia it has been recorded only in localized areas in the north. It is prevalent in much of eastern and south-eastern Botswana and also occurs in Ngamiland around the Okavango swamps and in north-eastern Chobe District (Paine, 1982). Extraliminally it is very widely distributed in the Afrotropical region.

***Boophilus microplus* (Canestrini, 1887)**

Species diagnosis: Hoogstraal (1956), Londt & Arthur (1975), Heyne (1986). It was referred to as *Boophilus (Uroboophilus) fallax* by Theiler (1962), but later she became convinced that this species is a synonym of *B. microplus* (Hoogstraal, 1956; Gertrud Theiler, unpublished data).

Hosts: Cattle are the primary hosts of this tick. It has only occasionally been collected from sheep, goats and horses (Theiler, 1943b; Hoogstraal, 1956; Mason & Norval, 1980). Records from wild animals are rare. They include the lion, *Panthera leo* (Carnivora, Felidae); grey rhebok, *Pelea capreolus*; sable antelope, *Hippotragus niger*, and buffalo, *Syncerus caffer* (Artiodactyla, Bovidae) (Theiler, 1962, Horak, Sheppey, Knight & Beuthin, 1986b). The indications are, therefore, that its potential host range resembles that of *B. decoloratus*.

Distribution: According to Howell *et al.* (1978) and Baker, Jordaan & Robertson (1979), in South Africa *B. microplus* occurs in the Transvaal to the north and east of Pretoria and in the Witbank, Belfast, White River, Barberton, Carolina, Ermelo, Standerton and Wakkerstroom Districts, also in KaNgwane. In Natal it has been found in the north in Ingwavuma, Newcastle, Hlabisa, lower Umfolozi and Mtunzini Districts and at the southern end of the province in Camperdown, Richmond, Ixopo, Umzinto, Port Shepstone and Alfred Districts. It also occurs in the Umzimkulu, Bizana, Flagstaff, Tabankulu, Lusikisiki, Libode, Tsolo, Ngqeleni, Elliotdale, Willowvale and Kentani areas of the Transkei. In the eastern Cape Province it is present in Stutterheim and Victoria East Districts, in the Ciskei at Keiskammahoek, and in isolated pockets

along the southern Cape coast in the districts of Humansdorp, Knysna, George, Mossel Bay, Heidelberg, Swellendam, Caledon and Robertson. It has been collected at several places in Swaziland (Jagger *et al.*, 1987). As yet, through, *B. microplis* has not been recorded in either Namibia or Botswana. Extraliminally it has been found in parts of East and Central Africa.

GENUS *COSMIOMMA* SCHULZE, 1919

Generic characteristics:

- (a) Ornate
- (b) Hypostome and palps long
- (c) Eyes present
- (d) Festoons present
- (e) Adanal plates in the male present

An extremely rare, monospecific Afrotropical genus.

Cosmiomma hippopotamensis (Denny, 1843)

Species diagnosis: Dönitz (1910, as *Hyalomma hippopotamense*), Arthur (1960). Originally Denny (1843) described the ♂ as *Ixodes bimaculatus* and the ♀ as *Ixodes hippopotamensis*. It has also featured in the literature as an *Amblyomma* and a *Dermacentor*. The adults are large ticks with a black pattern on their pale yellowish scutum and light-coloured mottling on the dorsal surfaces of their legs. Immature stages undescribed.

Hosts: The types were recorded from *Hippopotamus amphibius* (Artiodactyla, Hippopotamidae). Adults have since been found on the black rhinoceros, *Diceros bicornis* (Perissodactyla, Rhinocerotidae), which is now regarded as its most likely host (Bezuidenhout & Schneider, 1972). [In a report accompanying 6 adults sent to Onderstepoort for identification in 1960 it was stated that these ticks had been collected from cattle, although they preferred small stock, especially goats. Subsequent enquiries, though, revealed that this information was incorrect (State Veterinarian, Ohopoho, 1960, personal communication; Theiler, 1962; Bezuidenhout & Schneider, 1972)].

Distribution: The type locality for this species is recorded merely as "South Africa". Adults have since been collected in southern Africa only in Namibia, Kaokoland, in 1959 at Ohopoho and Otjijanjasemo, and in 1971 at Ondjarrakagha, Otjiboronbonga, Otjipembi and Ekoto (Bezuidenhout & Schneider, 1972). *C. hippopotamensis* has also been recorded extraliminally in Angola. A morphologically slightly different population occurs in Kenya.

GENUS *DERMACENTOR* KOCH, 1844

Generic characteristics:

- (a) Ornate
- (b) Hypostome and palps relatively short and broad
- (c) Eyes present
- (d) Festoons present
- (e) Adanal plates in the male absent

This relatively large genus is widely distributed in parts of North and Central America, Eurasia and Africa. Several species are extremely important human and animal parasites and some are vectors of various pathogens. Neither of the 2 species present in the Afrotropical region, though, is known to be of any economic importance. These are *Dermacentor*

circumguttatus, an elephant parasite that occurs from West Africa eastwards across the continent to western Uganda and Tanzania, and *D. rhinocerinus* (see below).

Morel (1969) placed the 2 African *Dermacentor* spp. in the genus *Amblyocentor* Schulze, 1932 but this classification is not universally accepted. Santos Dias (1963) regarded *Amblyocentor* merely as a subgenus of *Dermacentor*.

Dermacentor rhinocerinus (Denny, 1843)

Species diagnosis: Hoogstraal (1956), Arthur (1960), Clifford & Anastos (1964). The adults are large ticks with a striking black and deep gold scutal pattern. Larva undescribed.

Hosts: Adults feed primarily on both the white and the black rhinoceros, *Ceratotherium simum* and *Diceros bicornis* (Perissodactyla, Rhinocerotidae). Hoogstraal (1956) also listed it from various domestic animals, a jackal and eland (*Taurotragus oryx*), to which Theiler (1962) added the monitor lizard (*Varanus* sp.), elephant (*Loxodonta africana*), buffalo (*Syncerus caffer*) and roan antelope (*Hippotragus equinus*), but none of these animals are thought to be significant hosts of this species. Clifford & Anastos (1964) noted that adults and nymphae were collected from the nests of rodents and a macrosclid, an indication of the hosts of the immature stages.

Distribution: In South Africa *D. rhinocerinus* has been recorded in the Transvaal in the Kruger National Park. In northern Natal it occurs in Ndumu, Hluhluwe and Umfolozi Game Reserves plus the Corridor area between the latter 2 reserves (Baker & Keep, 1970), also at a few points in adjacent areas. In Namibia 1 ♂ was collected from a black rhinoceros at Grootfontein in 1933 (OP 2683 iii) but this species has apparently not been found there since. It has been widely recorded extraliminally in eastern, central, and other parts of southern Africa.

GENUS *HAEMAPHYSALIS* KOCH, 1844

Generic characteristics:

- (a) Inornate
- (b) Hypostome and palps short
- (c) Eyes absent
- (d) Festoons present
- (e) Adanal plates in the male absent

Much of our knowledge of this genus, the second largest in the family Ixodidae, is based on research carried out from 1955-85 by H. Hoogstraal and his colleagues. Their findings on the Afrotropical species were published in a series of papers under the general heading "Notes on African *Haemaphysalis* ticks". In these papers individual species were described, or redescribed, and Hoogstraal progressively developed his ideas regarding the subgenera, species groupings and relationships of the African haemaphysalids. His final conclusions were incorporated in a major study on tick and mammal coevolution with particular reference to *Haemaphysalis* species throughout the world (Hoogstraal & Kim, 1985).

Ten species of these small, light brown, eyeless ticks are currently known to occur in southern Africa. These fall into 4 of the 14 subgenera discussed by Hoogstraal & Kim (1985), as follows: *Ornithophysalis* (*hoodi*); *Haemaphysalis* (*silacea*); *Kaiseriana* (*aciculifer*, *parmata*), and *Rhipistoma* (*cool-eyi*, *hyracophila*, *leachi*, *pedetes*, *spinulosa*, *zumpti*).

Thus far the only *Haemaphysalis* species in southern Africa known to be a vector of any pathogens is *H. leachi*. It transmits *Babesia canis*, causing canine biliary fever, a disease that is frequently fatal. It also transmits *Rickettsia conorii*, which causes human tick-bite fever, and can harbour *Coxiella burnetii*, the causative agent of Q fever in animals and man.

***Haemaphysalis aciculifer* Warburton, 1913**

Species diagnosis: Hoogstraal & El Kammah (1972).

Hosts: Adults occur on cattle, sheep and goats. The commonest wild animal hosts are various large and small antelopes, especially bushbuck, *Tragelaphus scriptus*, and common duiker, *Sylvicapra grimmia*, and occasionally buffalo, *Syncerus caffer* (Artiodactyla, Bovidae). They have also been collected, but less commonly, from various carnivores (Carnivora, Canidae, Viverridae and Felidae) and from the Cape hare, *Lepus capensis* (Lagomorpha, Leporidae). The immature stages apparently feed primarily on various rodents (Rodentia, Muridae) and to a lesser extent on other small mammals, especially the smaller carnivores and hares (Hoogstraal & El Kammah, 1972; Horak *et al.*, 1986b; Horak, Keep, Spickett & Boomker, 1989).

Distribution: In South Africa *H. aciculifer* has been recorded from scattered localities in the northern and eastern Transvaal, including the Kruger National Park; at various places in Natal (Baker & Keep, 1970; Horak *et al.*, 1989), and in the western Cape (Horak *et al.*, 1986b). Theiler (1962) considers that this tick was introduced into South Africa on cattle imported from East Africa after the Boer War and the rinderpest pandemic. Although widely distributed it is never encountered in large numbers. Extraliminally it is widely distributed in East and Central Africa.

***Haemaphysalis cooleyi* Bedford, 1929**

Species diagnosis: Hoogstraal & Wassef (1981). Larva unknown. It is one of the 4 African species constituting the *Haemaphysalis* (*Rhipistoma*) *orientalis* subgroup that all parasitize dassies (hyraxes) (Hoogstraal, 1956; Hoogstraal, Walker & Neitz, 1971).

Hosts: The type specimens (3 ♂♂, 1 ♀, 1 N) were collected from a rock dassie, *Procavia capensis* (Hyracoidea, Procaviidae) (Hoogstraal & Wassef, 1981). Adults will also feed on the yellow-spotted rock dassie, *Heterohyrax brucei* (Norval, 1985). The record from *Procavia habessinica* in Theiler (1962), though, almost certainly refers to another species in the *orientalis* subgroup since this dassie occurs in the Ethiopian highlands (Corbet & Hill, 1986) whereas *H. cooleyi* is apparently confined to southern Africa.

Distribution: Currently the only confirmed record for *H. cooleyi* in South Africa is the type collection from the Transvaal, near Onderstepoort (OP 2454i). Theiler (1962) also listed it from several other localities in the Transvaal, Natal and eastern Cape, but of these collections only the specimens from the eastern Cape, New Bethesda (OP2974i), still exist. On re-examination these have proved to be *Haemaphysalis hyracophila* (see below). *H. cooleyi* has been recorded extraliminally in Zimbabwe.

***Haemaphysalis hoodi* Warburton & Nuttall, 1909**

Species diagnosis: Hoogstraal (1956); Matthyse & Colbo (1987). Immature stages undescribed.

Hosts: Domestic fowls (Lucas, 1954) and a wide range of ground-feeding wild birds (Aves), including

both non-passerine and passerine species.

Distribution: In South Africa it is recorded in the Transvaal at Bloemhof, Tzaneen, Newington and in the Kruger National Park; in Natal at Pietermaritzburg, and in the eastern Cape Province at East London; also in Botswana at Maun (Santos Dias, 1955). It is very widely distributed extraliminally in the Afrotropical region.

***Haemaphysalis houyi* Nuttall & Warburton, 1915**

This tick is not now thought to occur in southern Africa. It is a specific parasite of Geoffroy's ground squirrel, *Xerus erythropus*, which occurs in south-eastern Morocco and from Senegal across Africa to western Ethiopia and Kenya (Corbet & Hill, 1986). Theiler (1962) listed *H. houyi* from a few localities in the Transvaal, Orange Free State and Cape Province but commented: "The South African records need to be confirmed." Unfortunately the specimens on which these records were based apparently no longer exist.

***Haemaphysalis hyracophila* Hoogstraal, Walker & Neitz, 1971**

Species diagnosis: Hoogstraal *et al.* (1971). Like *H. cooleyi* this tick belongs to the *Haemaphysalis* (*Rhipistoma*) *orientalis* subgroup of dassie parasites.

Hosts: It is known only from the rock dassie, *Procavia capensis*, and one unidentified hyrax (Hyracoidea, Procaviidae) (Hoogstraal *et al.*, 1971; Norval, 1985).

Distribution: In South Africa it is recorded in the Cape Province, Clanwilliam District, in the Cedarberg; Montagu District, Kogman's Kloof, and Cradock District, Mountain Zebra National Park; also in the Transvaal, Letaba District, at Gravelotte. It occurs extraliminally in Zimbabwe.

***Haemaphysalis leachi* (Audouin, 1827)**

Species diagnosis: Hoogstraal (1958); Matthyse & Colbo (1987). It is now accepted that "leachi" is the correct spelling of this specific name. No subspecies of this tick are currently recognized (see also below under *Haemaphysalis spinulosa*). The information compiled under the name *H. leachii leachii* by Theiler (1962) undoubtedly includes several different entities. Hoogstraal (1964) commented: "The *leachii* group is the most polymorphic of any in this genus and, to date, the more it has been studied, the more confused the taxonomic status of its various components has become". Subsequently Hoogstraal and his colleagues J. L. Camicas and K. El Kammah clarified the situation somewhat by describing several new species in this group, among them *Haemaphysalis pedetes* and *Haemaphysalis zumpti* (see below). Various taxonomic problems are, however, still outstanding. Only recently Horak *et al.* (1987c) noted that they had been unable to differentiate the immature stages of the 2 commonest species in the group in southern Africa, *H. leachi* and *H. spinulosa*, which emphasizes the need for further research on their morphology. The following comment by Hoogstraal (1964) should be remembered by anyone trying to understand this difficult group of ticks: "The high degree of host specificity displayed by almost all species in the genus *Haemaphysalis* suggests the advisability of commencing any study of samples in the *leachii* group with a careful comparison of other samples from the same and from different host species, genera, and families".

Hosts: The adults of *H. leachi* are among the commonest ticks parasitizing domestic dogs (Hoogstraal,

1956; Horak *et al.*, 1987c). They are also found occasionally on cattle (Hoogstraal, 1956). They have been collected from many species of the larger wild carnivores (Carnivora, Canidae; Viverridae, in particular the civet, *Civettictis civetta*; Hyaenidae and Felidae) (Hoogstraal, 1956; Horak *et al.*, 1987c; J. B. Walker, unpublished data). Rodents are regarded as the preferred hosts of the immature stages (Hoogstraal, 1956), but the difficulty of identifying these stages specifically must be remembered.

Distribution: The accounts by Theiler & Robinson (1953a), and Theiler (1962), of the distribution of *H. leachi* (syn. *H. leachii leachii*) in southern Africa probably do refer to this species *sensu stricto* because their findings were based primarily on collections from dogs. They distinguished this dog tick from a similar species referred to in their 1953a publication as *H. leachi* var. *indica*, and in Theiler (1962) as *H. leachii muhsami*, collected from small wild carnivores (see below under *H. spinulosa*). Theiler (1962) commented that in southern Africa *H. leachi* is plentiful in areas with a mean annual rainfall of 635 mm (25 inches) or more, but occurs less frequently, and in smaller numbers, in areas with rainfalls of 508–635 mm (20–25 inches). She said it is absent where the rainfall is less than 508 mm per annum, i.e. in the north-western Cape, western and north-western Orange Free State, western Transvaal, the Kgalagadi (Kalahari) and southern Namibia. She also found it to be absent in areas with over 120 days of frost annually. More recent studies have confirmed the presence of *H. leachi* in Namibia, both in the north and once in the extreme south at Karasburg (Heloise Heyne, unpublished data). In Botswana it occurs primarily around the Okavango swamps, in the eastern part of the country and at various points along its southern border (Walker *et al.*, 1978; Paine, 1982). It is very widely distributed in the Afrotropical region.

***Haemaphysalis parmata* Neumann, 1905**

Species diagnosis: Theiler (1945c); Matthyse & Colbo (1987).

Hosts: The adults, which are extremely small and easily overlooked, have been recorded from cattle and other domestic animals but are primarily parasites of antelopes (Hoogstraal, 1956; Horak, Keep, Flamand & Boomker, 1988a). The immature stages often feed on the same animals as the adults. They have also been recorded from a wide range of other hosts, mostly smaller mammals such as mongooses and genets (Carnivora, Viverridae), various rodents, hares, and insectivores, but also birds (Aves), especially ground-feeding species such as guinea-fowls and francolins (Theiler, 1962).

Distribution: In South Africa *H. parmata* has been recorded only in Natal, in the Charter's Creek Nature Reserve (Horak *et al.*, 1988a) and Durban. Theiler (1962) questioned whether it was a recent introduction but its prevalence on red duikers (*Cephalophus natalensis*) in the Charter's Creek area suggests that this is not so. Extralimitally it is widely distributed from Sierra Leone in West Africa eastwards across the continent to Ethiopia and the East African countries.

***Haemaphysalis pedetes* Hoogstraal, 1972**

Species diagnosis: Hoogstraal (1972). Nymph undescribed; larva unknown.

Hosts: Adults and nymphae are parasites of the springhare, *Pedetes capensis* (Rodentia, Pedetidae) (Hoogstraal, 1972; Norval, 1985). According to

Hoogstraal & Kim (1985) adults have also been collected "from carnivores of the genera *Felis*, *Ictonyx* and *Herpestes*" (Felidae, Mustelidae and Viverridae).

Distribution: South Africa, Transvaal, Pienaar's River. It also occurs extralimitally in Zimbabwe (Norval, 1985).

***Haemaphysalis rugosa* Hoogstraal & El Kammah, 1972**

This rare species, which closely resembles *H. aciculifer*, is not currently thought to occur in southern Africa. It is known from the Senegal, Ghana, Uganda and the Sudan. In their original description of this tick Hoogstraal & El Kammah (1972) also included the following information: "Questionable record (South Africa). From *Felis* (= *Leptailurus*) *s. serval*, Pietermaritzburg, 2,500 ft alt., Natal Province, date not stated but earlier than 1936, R. F. Lawrence: 3 ♂ (HH 42,565) (Onderstepoort 2446ii). [This lot, which also contains 1 ♀ *H. (K.) aciculifer* (HH 42,564), is either mixed and mislabelled or represents a remarkable discontinuity in *H. (K.) rugosa* distribution. Unless it can be proven that *H. (K.) rugosa* occurs in South Africa, we are inclined to disregard this record]". I endorse this statement.

***Haemaphysalis silacea* Robinson, 1912**

Species diagnosis: Hoogstraal (1963).

Hosts: Sheep, goats, cattle and various antelopes (Artiodactyla, Bovidae) act as hosts of all stages (Norval, 1975a; Knight & Rechav, 1978; Horak *et al.*, 1983b). Kudu, *Tragelaphus strepsiceros*; bush-buck, *Tragelaphus scriptus*, and eland, *Taurotragus oryx*, are preferred and may be particularly heavily infested. The common duiker, *Sylvicapra grimmia*, is also a good host. Immature stages only have been found on dogs; on some of the smaller wild carnivores, especially the caracal, *Felis caracal* (Carnivora, Canidae, Viverridae and Felidae), and on occasional rodents and hares. Various birds (Aves) may also be infested by the immature stages, particularly the hadeda ibis, *Hagedashia hagedash*, and the helmeted guineafowl, *Numida meleagris* (Norval, 1975a; Horak & Williams, 1986).

Distribution: *H. silacea* occurs only in South Africa, where it is found primarily in the eastern Cape Province in localized areas of Fish River Bush, a xerophytic scrub thicket vegetation that is characteristic of the hot dry ravines and river valleys in this region. It is also established in northern Zululand, in the Mkuze, Hluhluwe, Umfolozi and St Lucia areas (Baker & Keep, 1970; Horak *et al.*, 1988a). Further south it has been collected in the Umgeni Valley Nature Reserve; in the Bayne's Drift area north of Pietermaritzburg, and in the Vernon Crooks Nature Reserve, Umzinto.

***Haemaphysalis spinulosa* Neumann, 1906**

Species diagnosis: Hoogstraal (1964), Hussein & Mustafa (1983). It was recorded by Theiler (1962) as *H. leachii muhsami* Santos Dias, 1954, with *H. leachii* var. *indica sensu* Theiler (1943b) given provisionally as its synonym. In 1964 Hoogstraal re-described *H. spinulosa*, though he still had reservations about its status. He commented: 'Study of both syntypes of *H. spinulosa* reveals that this is in fact a "small form" of *H. leachii* that has been obscured by inadequate description and incorrect illustration. The question of whether *H. spinulosa* is a synonym, a subspecies, or a full species closely related to *H. leachii* must await further study'. Finally Camicas, Hoogstraal & El Kammah (1972) recognized *H. spi-*

nulosa as a full species, with *H. muhsamae* as its junior synonym. As in the case of *H. leachi* the information given by Theiler (1962) about *H. spinulosa* undoubtedly covers more than one entity (see especially *H. zumpti*). Horak *et al.* (1987c) were unable to differentiate the immature stages of *H. leachi* and *H. spinulosa*.

The entity originally described by Warburton (1910) as *H. leachi* var. *indica* is now regarded a full species, *H. indica*, occurring in the Oriental and Palaearctic regions (Hoogstraal & Kim, 1985), not in Africa.

Hosts: Adults of *H. spinulosa* have been found occasionally on domestic dogs and cats (Horak *et al.*, 1987c; J. B. Walker, unpublished data). They occur most frequently on wild carnivores, primarily on the smaller species such as mongooses and genets (Viverridae) though they have also been collected from various members of the families Canidae and Felidae (Horak *et al.*, 1987c). I have great reservations about some of the hosts listed for this species by Theiler (1962), in particular those from various dasiids (Hyracoidea) since their parasites are usually very host specific.

Distribution: In South Africa Theiler & Robinson (1953a) commented, with reference to their *H. leachi* var. *indica*, that "... the wild carnivores and their tick variety, are present throughout South Africa extending even into the more arid areas..." This statement cannot at present be confirmed because many of the ticks on which they based it are no longer available and existing collections of *H. spinulosa* by no means cover the whole area. Specimens have been seen from the Transvaal, Kruger National Park; Natal, Vernon Crookes Nature Reserve, Umzinto; Orange Free State, and eastern Cape Province from various places (J. B. Walker, unpublished data; I. G. Horak, unpublished data). In Namibia a single ♂ only has been recorded in Windhoek District. Extralimitally *H. spinulosa* is very widely distributed in the Afrotropical region.

***Haemaphysalis tauffliebi* Morel, 1965**

Although this tick was recorded from South Africa by Hoogstraal & Wassef (1973) it now seems virtually certain that it does not in fact occur here. These authors, who stated that its hosts are "various birds and small mammals", gave its range as "Ethiopia to West Africa and South Africa". The only known record from South Africa, though, is of 3 ♀♀, 2 NN, from the plainbacked pipit, *Anthus leucophrys* (Aves, Passeriformes), East London, eastern Cape Province, October 1966, collected by S. van der Merwe (HH 7301, RML 79689). Unfortunately the present whereabouts of this collection is unknown (J. E. Keirans, personal communication, 1991).

***Haemaphysalis zumpti* Hoogstraal & El Kammah, 1974**

Species diagnosis: Hoogstraal & El Kammah (1974). A small tick in the *H. leachi* group, closely related to *H. pedetes* (Hoogstraal & Kim, 1985). Its immature stages are difficult to distinguish morphologically from those of *H. leachi* and *H. spinulosa*.

Hosts: Adults of *H. zumpti* have been collected from a wide range of small carnivores (Mustelidae, Viverridae, Protelidae and Felidae) and the tree squirrel, *Paraxerus cepapi* (Rodentia, Sciuridae). The most commonly recorded hosts are the suricate, *Suricata suricatta*, and the yellow mongoose, *Cynictis penicillata*, which share the burrow systems of the

ground squirrel, *Xerus inauris*. This squirrel and *P. cepapi* are both known hosts of the immature stages. Some of the records from these hosts listed under the name *H. leachii muhsami* by Theiler (1962) probably refer to this species.

Distribution: It occurs in the eastern part of South Africa, from scattered localities in the Transvaal, Orange Free State and eastern Cape Province, and in Botswana at Francistown and Chobe River (Hoogstraal & El Kammah, 1974). It also occurs extralimitally in Zambia.

GENUS *HYALOMMA* KOCH, 1844

Generic characteristics:

- (a) Scutum inornate
- (b) Legs banded
- (c) Hypostome and palps long
- (d) Eyes present
- (e) Festoons present, but sometimes not as well defined as in other genera
- (f) Adanal, accessory adanal and subanal plates in the male present

Members of this genus, one of the smaller ones in the family Ixodidae, occur in the Palaearctic, Oriental and Afrotropical regions. Individual species often show a great range of morphological variation. The failure of most workers to appreciate this, plus the fact that for a long time the species described in 1844 by Koch (cited by Hoogstraal, 1956) largely remained unrecognised, resulted in the nomenclatorial chaos that prevailed in the genus for many years. Much of this confusion was resolved some 40 years ago, primarily through painstaking research by S. Adler and B. Feldman-Muhsam in Israel and by L. Delpy in Iran. The genus was reviewed in detail by Hoogstraal (1956).

There are indications in various species in this genus that the type of life cycle followed is influenced by the prevailing environmental conditions and hosts (Hoogstraal, 1956; Balashov, 1972). Under controlled laboratory conditions, at 26 ± 1 °C, when the immature stages were fed on rabbits and the adults on calves, *Hyalomma marginatum rufipes* behaved as a 2-host species (Knight, Norval & Rechav, 1978).

Three entities belonging to this genus are widespread in the drier parts of southern Africa. The adults' habit of actively seeking potential hosts detected in their vicinity, including humans, is well-known to many field workers. *Hyalomma* spp. are regarded with particular caution by most people because they are the primary vectors of the virus causing Crimean-Congo haemorrhagic fever in man (Hoogstraal, 1979; Swanepoel, Shepherd, Leman, Shepherd, McGillivray, Erasmus, Searle & Gill, 1987). *H. marginatum rufipes* (syn. *H. aegyptium* var. *impressum*) has also been shown to harbour a *Rickettsia* sp. identical with strains that produce tick typhus in man. Recently *H. truncatum* has been found to be an efficient vector of *Babesia caballi*, the causative agent of equine babesiosis (De Waal, 1990). Some strains of *H. truncatum* produce a dermatotropic toxin that causes sweating sickness in cattle, especially calves (Neitz, 1959). Two cases of paralysis in man caused by this tick are on record (Swanepoel, 1959). The bites of adult *Hyalomma* spp. cause wounds that may be invaded either by bacteria, resulting in the formation of abscesses, sloughing of teats and tailtips, lameness and footrot,

or by larvae of the screwworm, *Chrysomya bez-ziana*. In dogs large necrotic lesions, thought to be caused by a dermatropic toxin, sometimes develop around the bites of *H. truncatum* adults (Burr, 1983).

Hyalomma marginatum rufipes Koch, 1844

Species diagnosis: Hoogstraal (1956, as *H. rufipes*), Arthur (1975a, b). Doubt still exists regarding the correct name of this tick. Koch (1844) originally described *H. marginatum* and *H. rufipes* as separate species and they have been treated thus by many people ever since, for example Theiler (1962) and Keirans (1985). In 1960, though, Hoogstraal & Kaiser stated: "After exhaustive study of large numbers of *H. marginatum*, *rufipes*, and *turanicum* from numerous areas in Europe, Africa, and Asia, it has become apparent that each of these forms is a geographical but closely related subspecies . . . The study of this subject is nearing completion and will be presented shortly". Unfortunately, though, their results never were presented in greater detail. Despite this, many researchers, following the lead of Hoogstraal himself, subsequently referred to this tick as *H. marginatum rufipes*, a name that is now well established in the more recent South African literature. To revert immediately to the name *H. rufipes* would seem to I. G. Horak (personal communication, 1990) and the writer to negate, perhaps unjustifiably, the validity of Hoogstraal & Kaiser's findings. This could cause even greater confusion later. We suggest, therefore, that someone should look at this problem again and, after due consideration, resolve it formally.

Theiler (1962) lists many other synonyms under which this tick has featured in the literature from time to time.

Hosts: The primary domestic hosts of the adults of *H. m. rufipes* are cattle; other domestic animals are rarely infested. They also parasitize the larger wild ungulates, such as zebra, *Equus* spp. (Perissodactyla, Equidae); giraffe, *Giraffa camelopardalis*; buffalo, *Syncerus caffer*, and eland, *Taurotragus oryx* (Artiodactyla, Giraffidae and Bovidae) (Theiler, 1962). The immature stages feed very commonly on birds (Aves), of which many species have been recorded as hosts (Hoogstraal, 1956; Hoogstraal, Kaiser, Traylor, Gaber & Guindy, 1961; Theiler, 1962). Both the Cape hare, *Lepus capensis*, and the scrub hare, *Lepus saxatilis* (Lagomorpha, Leporidae) are also favoured by the immature stages (Rechav, 1986; Horak & MacIvor, 1987). Theiler (1962) lists various other small mammals, particularly insectivores and rodents, as hosts of the immatures, but their role in the maintenance of this species is at present open to question. Horak & MacIvor (1987) found that the rodents they examined were infested by *H. truncatum*, not this species.

Distribution: *H. m. rufipes* is very widely distributed in southern Africa. In South Africa it does not occur in the easternmost parts of the Transvaal, Swaziland, KwaZulu, Natal, Orange Free State, Transkei and eastern Cape Province, nor in most parts of the southern and south-western Cape Province, but is prevalent elsewhere. In Namibia it is precariously established or absent in the driest areas and dies out in the moister, more tropical parts of northern Owambo, but occurs throughout the rest of the country (Theiler, 1956, 1962). It has also been collected in many parts of Botswana (Walker *et al.*, 1978; Paine, 1982). Extralimitally it is widely distributed in the Afrotropical region.

Hyalomma marginatum turanicum Pomerantsev, 1946

Species diagnosis: Hoogstraal (1956, as *H. turanicum*). Immature stages undescribed. It was listed by Theiler (1962) as *H. glabrum*. Further comments on its nomenclature appear above under *H. m. rufipes*.

Hosts: This species apparently favours the same hosts as *H. m. rufipes*. The adults feed on "domestic stock, mainly sheep" (Theiler, 1962). Horak & MacIvor (1987) found numerous adults on the Cape mountain zebra, *Equus zebra zebra* (Perissodactyla, Equidae) and eland (*Taurotragus oryx*), but few on the springbok, *Antidorcas marsupialis*, and black wildebeest, *Connochaetes gnou* (Artiodactyla, Bovidae), present in the same area. They collected the immature stages in large numbers from scrub hares, *Lepus saxatilis*, but larvae only, in smaller numbers, from Smith's red hares, *Pronolagus rupestris* (Lagomorpha, Leporidae). Both larvae and nymphae were found on spring hares, *Pedetes capensis* (Rodentia, Pedetidae) and various birds (Aves).

Distribution: This subspecies is thought to have been introduced from the Near East (Theiler, 1962). Its distribution in South Africa is restricted to "the Karoo areas of the Eastern Cape, Western and South-western Cape, and the Cape Midlands as also in the Brokenveld of the Southern Orange Free State" (Theiler, 1956). It has not been recorded elsewhere in the Afrotropical region.

Hyalomma truncatum Koch, 1844

Species diagnosis: Hoogstraal (1956). Immature stages undescribed. Theiler (1962) lists many synonyms for this tick, including *H. transiens*, a name under which it often appears in the older South African literature.

Hosts: The adults feed on cattle and other domestic animals, including dogs, but usually not in great numbers (Yeoman & Walker, 1967; Horak & MacIvor, 1987). They have been recorded from many wild animals, among them various large and small carnivores (Carnivora, Canidae and Felidae) and a wide range of ungulates (Perissodactyla and Artiodactyla). Although, like *H. m. rufipes* adults, they apparently prefer the larger ungulates they have also been found on some of the medium-sized and smaller species (Theiler, 1962; Norval, 1982). The immature stages have a strong predilection for the Cape hare, *Lepus capensis*, and the scrub hare, *Lepus saxatilis*, and to a lesser extent for Smith's red hare, *Pronolagus rupestris* (Lagomorpha, Leporidae). They have also been collected from various rodents (Theiler, 1962; Rechav, 1986; Horak & MacIvor, 1987). The latter authors failed to obtain this species from 42 birds, belonging to 6 species, that they examined in the same area. This observation corroborates that of Hoogstraal *et al.* (1961), who did not include *H. truncatum* among the species collected from the 340 northward-migrating birds, belonging to 22 "host forms", that they listed as tick-infested in Egypt. These findings raise doubts about the accuracy of the records of *H. truncatum* immatures from birds in Theiler (1962). Her records of this species from reptiles are thought to represent accidental infestations.

Distribution: In South Africa *H. truncatum* occurs almost throughout the country east, north and west of a line drawn from Barberton via Lydenburg to Pretoria and Krugersdorp, then southwards via Bloemfontein to the coast at Alexandria. In the east its distribution zone extends from Barberton south-

wards through eastern Swaziland and northern KwaZulu/Natal as far as Nkandla (Theiler, 1956; 1962). Apart from the dry coastal areas it is present throughout Namibia and in most parts of Botswana (Theiler, 1962; Walker *et al.*, 1978; Paine, 1982). Extralimitally it is widely distributed in the Afro-tropical region.

GENUS *IXODES* LATREILLE, 1796

Generic characteristics:

- (a) Inornate
- (b) Hypostome and palps long
- (c) Eyes absent
- (d) Festoons absent
- (e) Anal groove anterior to the anus. (In all other genera the anal groove is posterior to the anus)

This is the second largest genus in southern Africa (and in the world context by far the largest genus in the family Ixodidae), containing 25 species plus several entities in the *pilosus* group that are as yet undescribed.

In general the *Ixodes* species remain poorly understood. Four species (*catherinei*, *myotomys*, *spiculae*, and *transvaalensis*) are known only from the few specimens in the type collections. Only one species in southern Africa, *Ixodes rubicundus*, is currently known to be economically important as the females cause tick paralysis in various species of domestic and wild animals.

The identity of many collections of *Ixodes* spp. in the Onderstepoort Tick Collection was confirmed by C. M. Clifford (unpublished data, 1969).

Ixodes alluaudi Neumann, 1913

Species diagnosis: Theiler (1941); Arthur (1965).

Hosts: Both the adults and immature stages prefer shrews, especially the greater musk shrew, *Crocidura flavescens* (Insectivora, Soricidae), also various rodents (Rodentia, Bathyergidae and Muridae) (Theiler, 1962).

Distribution: Scattered localities throughout South Africa and in Lesotho. It also occurs extralimitally.

Ixodes aulacodi Arthur, 1956

Species diagnosis: Arthur (1965), Morel (1966). Male and nymph unknown.

Hosts: Females and immature stages are recorded from the greater cane-rat, *Thryonomys swinderianus* (Rodentia, Thryonomyidae) also the large grey mongoose, *Herpestes ichneumon*, (Carnivora, Viverridae) and a bird (Aves), the helmeted guinea-fowl, *Numida meleagris*.

Distribution: South Africa, KwaZulu/Natal, Ndumu Game Reserve, and the farm "Faraway" near Eston. It also occurs extralimitally.

Ixodes bakeri Arthur & Clifford, 1961

Species diagnosis: Arthur & Clifford (1961); Clifford, Walker & Keirans (1976).

Hosts: Both the adults and immature stages parasitize rodents, especially *Otomys* spp. (Rodentia, Muridae), and the shrews *Crocidura mariquensis* and *Myosorex varius* (Insectivora, Soricidae).

Distribution: It is known only from South Africa, in the Transvaal, Van Riebeeck Nature Reserve; Natal, Midmar Dam, and western Cape Province, Jonkershoek Valley.

Ixodes bedfordi Arthur, 1959

Species diagnosis: Arthur (1965). Immature stages unknown.

Hosts: The adults feed on rodents (*Otomys* and *Rhabdomys* spp.) (Rodentia, Muridae).

Distribution: Lesotho, several localities. Theiler (1962) suggested that South African collections previously identified as *Ixodes nairobiensis*, from Natal, Cathedral Peak, and Cape Province, Lady Gray, may also belong to this species; this cannot be confirmed because these specimens apparently no longer exist.

Ixodes catherinei Keirans, Clifford & Walker, 1982

Species diagnosis: Keirans *et al.* (1982). Only the type collection of 6 ♀♀ is known.

Host: The scrub hare, *Lepus saxatilis* (Lagomorpha, Leporidae).

Distribution: South Africa, eastern Cape Province, Clark's Siding, near Dordrecht.

Ixodes cavipalpus Nuttall & Warburton, 1908

Species diagnosis: Arthur (1965). Nymph unknown.

Hosts: Adults have been collected from a wide range of animals, including Primates, both large and small species of domestic and wild carnivores (Carnivora, Canidae, Viverridae and Felidae) and various antelopes (Artiodactyla, Bovidae).

Distribution: It is probably the most widespread *Ixodes* sp. in the Afrotropical region. In South Africa, Transvaal, it has been recorded near Pietersburg; at Nylsvley Nature Reserve, near Naboomspruit, and in Suikerbosrand Nature Reserve. In south-east Botswana there are records from Machaneng Mines near Kanye, and Otse.

Ixodes corwini Keirans, Clifford & Walker, 1982

Species diagnosis: Keirans *et al.* (1982).

Hosts: The adults and immature stages prefer Carnivora, including domestic dogs (Canidae), also the clawless otter, *Aonyx capensis* (Mustelidae); genets (*Genetta genetta*, *G. tigrina*), and mongooses (*Galerella sanguinea*, *G. pulverulenta*) (Viverridae).

Distribution: It is known only from South Africa, in Natal, Oribi Gorge, and in the southern border areas of Cape Province from Grahamstown to Kommetjie, near Cape Town.

Ixodes daveyi Nuttall, 1913

Arthur (1965) listed 3 ♀♀ of this avian tick "from *Procapia capensis*, Petersburg (*sic*), 29. IX. 54. (Onderstepoort collection)". I cannot confirm this record as I have been unable to trace these specimens. It occurs extralimitally in Ecast and Central Africa.

Ixodes drakensbergensis Clifford, Theiler & Baker, 1975

Species diagnosis: Clifford *et al.* (1975).

Hosts: Both adults and immature stages are recorded from a bovine, goats and an eland, *Taurotragus oryx* (Artiodactyla, Bovidae).

Distribution: This species is known only from South Africa, Natal, in Giant's Castle Nature Reserve and Dip Tank Area 118 (29° 35' S, 29° 50' E).

Ixodes elongatus Bedford, 1929

Species diagnosis: Arthur (1965). Only the ♀ is known.

Hosts: Rats and mice (Rodentia, Muridae); shrews (Insectivora, Soricidae), and elephant-shrews (Macroscelidea, Macroscelididae).

Distribution: South Africa, Transvaal, from Pretoria and Onderstepoort. Theiler (1962) suggested that some specimens from the eastern Cape Province, Aliwal North and Grahamstown, originally identified as *Ixodes nairobiensis*, might belong to this species. This cannot be confirmed because these ticks apparently no longer exist. It also occurs extraliminally.

***Ixodes myotomys* Clifford & Hoogstraal, 1970**

Species diagnosis: Clifford & Hoogstraal (1970). Only the type ♀ is known.

Host: The bush Karoo rat, *Otomys unisulcatus* (syn. *Myotomys unisulcatus*) (Rodentia, Muridae).

Distribution: South Africa, western Cape Province, Little Namaqualand, Port Nolloth.

***Ixodes neitzi* Clifford, Walker & Keirans, 1977**

Species diagnosis: Clifford *et al.* (1977). Immature stages unknown.

Hosts: Mountain reedbuck, *Redunca fulvorufula*, and impala, *Aepyceros melampus* (Artiodactyla, Bovidae) (Clifford *et al.*, 1977; Norval, Spickett & Clifford, 1987).

Distribution: South Africa, Transvaal, Loskop Dam Nature Reserve (type locality). It also occurs extraliminally in Zimbabwe.

***Ixodes pilosus* group**

A. M. Spickett (personal communication, 1990) considers that ticks recorded as *Ixodes pilosus* Koch, 1844 by Theiler (1950c, 1962), plus other specimens obtained subsequently, can be separated into several closely related species which together constitute the *Ixodes pilosus* group. These ticks have been recorded from a wide range of mammals, including Insectivora, Primates, Carnivora, Artiodactyla, Lagomorpha and Rodentia.

The various members of this group occur primarily in South Africa, where they have been recorded from widely separated areas in the Transvaal, Swaziland, Natal, Transkei and Cape Province. One species has been recorded extraliminally in Zimbabwe (Norval *et al.*, 1987).

***Ixodes pilosus* Koch, 1844**

Species diagnosis: Nuttall & Warburton (1911).

Hosts: All stages often feed on the same hosts. Cattle and dogs appear to be the most favoured domestic animals. Amongst wild animals various antelopes have been recorded as hosts, particularly the grey rhebok, *Pelea capreolus*; bushbuck, *Tragelaphus scriptus*, and common duiker, *Sylvicapra grimmia* (Artiodactyla, Bovidae) (Horak *et al.* 1986b, 1987c, 1989). The immature stages have also been collected from several smaller animals, especially the caracal, *Felis caracal*; black-backed jackal, *Canis mesomelas*, and bat-eared fox, *Otocyon megalotis* (Carnivora, Felidae and Canidae), and the scrub hare, *Lepus saxatilis* (Lagomorpha, Leporidae).

Distribution: *I. pilosus sensu stricto* has been recorded in southern Natal, Alfred District, in Weza State Forest (Horak *et al.*, 1989), and in Cape Province, both in the east, at various places in Albany District, and in the south-west in the Bontebok National Park (Horak *et al.*, 1986b, 1987c).

***Ixodes procaviae* Arthur & Burrow, 1957**

Species diagnosis: Arthur (1965). Larva unknown.

Host: The ♀ and nymph parasitize the rock dassie, *Procavia capensis* (Hyracoidea, Procaviidae).

Distribution: South Africa, Natal, in Giant's Castle Game Reserve and nearby at Ntabamhlophe, also in the Umgeni Valley. Extraliminally a few records exist from Kenya, Rwanda and Zaïre.

***Ixodes pterodromae* Arthur, 1960**

Species diagnosis: Arthur (1965). The holotype ♀ is said to have been deposited "in the Onderstepoort Research Station" but is not present now, and is not recorded in the Onderstepoort Tick Collection catalogue. Larva unknown.

Hosts: Primarily marine birds (wandering albatross, petrels, fleshfooted shearwater) (Aves) (Arthur, 1965). It is also recorded from a feral cat.

Distribution: Marion Island. It is widely distributed extraliminally.

***Ixodes rhabdomysae* Arthur, 1959**

Species diagnosis: Arthur (1965). The holotype ♀ "Onderstepoort Research Station collection No. 609", is said to have been deposited at the "Onderstepoort Research Station", but it is not present now and is not listed in the Onderstepoort Tick Collection Catalogue.

Host: The striped mouse, *Rhabdomys pumilio* (Rodentia, Muridae).

Distribution: South Africa, eastern Cape Province, Howison's Poort (given as Howieson's Poort), and Hellensbord (not located).

***Ixodes rubicundus* Neumann, 1904**

Species diagnosis: Arthur (1965).

Hosts: The adults are important parasites of sheep, cattle and goats, and to a lesser extent of other domestic animals. They also parasitize wild animals, particularly the caracal, *Felis caracal* (Carnivora, Felidae) and various antelopes, especially the mountain reedbuck, *Redunca fulvorufula*, and eland, *Taurotragus oryx* (Artiodactyla, Bovidae). The immature stages are most prevalent on Smith's red hare (red rock rabbit), *Pronolagus rupestris* (Lagomorpha, Leporidae) and on caracal (Theiler, 1962; Horak, Moolman & Fourie, 1987a).

Distribution: It is confined to South Africa, with its main focus in "the southern parts of the Orange Free State and in the heart of the Karoo" (Spickett & Heyne, 1988). It occurs south-west of this main focus in Murraysburg, Aberdeen and Jansenville Districts, and southwards in Cradock District. It is also present in a number of places in the western Cape, notably in Sutherland, Worcester and Montagu Districts. North-east of its main focus *I. rubicundus* appears to be established in the Transvaal in both Heidelberg and Belfast Districts, and in Natal in the Dargle (Lion's River) area.

***Ixodes simplex simplex* Neumann, 1906**

Species diagnosis: Arthur (1965).

Hosts: Bats, commonly on Schreiber's long-fingered bat, *Miniopterus schreibersi* and *Miniopterus* sp., also on horseshoe bats, *Rhinolophus* spp. (Chiroptera, Vespertilionidae and Rhinolophidae). Only ♀♀, nymphae and larvae are present in the Onderstepoort Collection. Males probably do not feed, or feed rapidly and then detach again (Arthur, 1965).

Distribution: Recorded in South Africa, Transvaal, from Makapansgat; Zebediela; Rooi-

berg, near Warmbaths; Sterkstroom Cave; Pretoria, and Zwartkop Cave; and in western Cape Province, from Kalk Bay and Bredasdorp. It is very widely distributed extraliminally.

***Ixodes simplex africanus* Arthur, 1956**

Species diagnosis: Arthur (1965). Only the type ♀ was previously known, from Kenya, Mt. Menengai.

Hosts: A long-fingered bat, *Miniopterus* sp. (1 ♀) (Chiroptera, Vespertilionidae) and "bat" (2 nymphae).

Distribution: In South Africa, Transvaal, it is recorded from Krugersdorp (Kromdraai, Grobbelaar's Lower Cave), and Sandspruit (possibly at Rooiberg, near Warmbaths). It also occurs extraliminally in Kenya.

***Ixodes spiculae* Arthur, 1956**

Species diagnosis: Arthur (1956, 1965). His description is based on a single ♂ from South Africa, host and locality unknown. Arthur (1956, p. 184, last paragraph), in an apparent reference to this species, not to *Ixodes vespertilionis*, commented: "The structure of Haller's organ on tarsus I most strongly suggests that it is a species associated with bats. . . It is very probable that this male will prove to be that of an already described female, but it is unsafe at present to attribute it to any known species".

***Ixodes spinae* Arthur, 1958**

Species diagnosis: Arthur (1965). Immature stages unknown. The holotype ♂ and allotype ♀, from *Procavia capensis*, Pietersburg, South Africa, 20.IX. 1954, are said to have been deposited at the "Onderstepoort Veterinary Research Department" but they are not present now, and are not recorded in the Onderstepoort Tick Collection Catalogue. The present whereabouts of these types, if they still exist, is unknown.

Host: The rock dassie, *Procavia capensis* (Hyracoidea, Procaviidae).

Distribution: South Africa, Transvaal, Pietersburg, and western Cape Province, Cedarberg, from the farm "Middelburg". It also occurs extraliminally.

***Ixodes theileri* Arthur, 1958**

Species diagnosis: Arthur (1965). Only the ♀ is known.

Hosts: An avian parasite, collected from various species of Passeriformes.

Distribution: A southern African species, recorded in South Africa from the Transvaal, Pretoria and Onderstepoort; KwaZulu, Ndumu; Orange Free State, Ficksburg and Bothaville; western Cape Province, Cape Town; also in Namibia, Marienthal District (formerly Gibeon) at Marienthal itself.

***Ixodes transvaalensis* Clifford & Hoogstraal, 1966**

Species diagnosis: Clifford & Hoogstraal (1966). Only the type collection of 2 ♀♀ is known.

Host: Found in the nest of a Namaqua rock mouse, *Aethomys namaquensis* (Rodentia, Muridae).

Distribution: Collected in South Africa, western Cape Province, at Citrusdal. [The specific name *transvaalensis* is a misnomer, based on inadvertent mislabelling of the type collection at some point by an unknown person (C. M. Clifford, personal communication, 1989)].

***Ixodes ugandanus* Neumann, 1906**

Species diagnosis: Arthur (1965).

Host: The greater cane-rat, *Thryonomys swinderianus* (Rodentia, Thryonomyidae).

Distribution: South Africa, "Zululand" (precise locality unknown), 1 ♀ confirmed. Other specimens from KwaZulu, Umfolozi, and Transvaal, Tzaneen are regarded as questionable. [A ♀ collected at Louis Trichardt, originally listed under *I. ugandanus* by G. Theiler (1962), was reidentified merely as "*Ixodes* sp." by C. M. Clifford (unpublished data, 1969)]. It also occurs extraliminally.

***Ixodes uriae* White, 1852**

Species diagnosis: Arthur (1965).

Hosts: The females and immature stages feed on marine birds (Aves). In southern African waters various species of penguins, albatrosses, petrels, the broadbilled prion, Cape hen, and kelp gull are recorded as hosts. The males have rudimentary mouthparts, so probably do not feed. They have been collected in copula with ♀♀ in the hosts' breeding places (Arthur, 1965).

Distribution: Recorded in South Africa, eastern Cape Province, at Kleinemonde, and in western Cape Province from Table Bay; also from Marion Island. It is very widely distributed extraliminally.

***Ixodes vespertilionis* Koch, 1844**

Species diagnosis: Arthur (1965).

Hosts: Bats (Chiroptera). In southern Africa it has been collected from Sundevall's leaf-nosed bat, *Hipposideros caffer* (Hipposideridae) and Temminck's hairy bat, *Myotis tricolor* (Vespertilionidae).

Distribution: Recorded in South Africa, Transvaal, from Sterkfontein Cave, and in eastern Cape Province, at Lootsberg. It is very widely distributed extraliminally.

GENUS *MARGAROPUS* KARSCH, 1879

Generic characteristics:

- (a) Inornate
- (b) Hypostome and palps short
- (c) Eyes present, but often extremely difficult to see in the males
- (d) Festoons absent. Conspicuous setae, either in tufts or in a fringe, round the posterior end of the body of the male
- (e) Adanal plates in the male present
- (f) Leg segments in the male greatly expanded

This Afrotropical genus contains only 3 species, of which one (*winthemi*) occurs in South Africa and the other 2 (*reidi* and *wileyi*) in eastern Africa. At one time *Margaropus winthemi* was thought to have been introduced from Valparaiso, Chile, but this theory has now been discounted (Theiler, 1962).

Margaropus is closely related to *Boophilus* and, like the blue ticks, *M. winthemi* is a one-host species.

***Margaropus winthemi* Karsch, 1879**

Species diagnosis: Walker & Laurence (1973), Gothe (1967), Arthur (1975a).

Hosts: As its common name, the winter horse tick, indicates, its commonest domestic hosts are horses, though it also infests cattle. Massive infestations have also been found on the Cape mountain zebra *Equus zebra zebra* (Perissodactyla, Equidae) (Young, Zumpt, Boomker, Penzhorn & Erasmus,

1973; Horak, Knight & De Vos, 1986a), and smaller numbers on the gemsbok, *Oryx gazella* (Artiodactyla, Bovidae) (Horak *et al.* 1983b). Another bovid, the eland, *Taurotragus oryx*, was recorded as a host by Gertrud Theiler (unpublished data).

Distribution: *M. winthemi* has been recorded only in southern Africa. In South Africa it has been found in the Transvaal at a few places in the west and north-west, also in the south-eastern Highveld; in Lesotho; at scattered points in the Orange Free State, especially in the south and west; in the higher parts of southern Natal and the Transkei; at places in the north-eastern and eastern Cape Province, in the Cape Midlands and in areas bordering on the Karoo in the southern and western Cape Province (Theiler & Salisbury, 1958; Theiler, 1962; Horak *et al.*, 1986a). Records in Namibia from Windhoek and Rehoboth District, and in Botswana from Francistown, are thought to represent introductions only (Theiler, 1962).

GENUS *RHIPICENTOR* NUTTALL & WARBURTON, 1908

Generic characteristics:

- (a) Inornate
- (b) Hypostome and palps short
- (c) Eyes present
- (d) Festoons present
- (e) Adanal plates in the male absent
- (f) Males with coxa IV much larger than the others and bearing 2 spurs

This exclusively Afrotropical genus, containing only 2 species, was reviewed by Theiler (1961). Care is necessary to avoid confusing these ticks with *Rhipicephalus* spp.

Rhipicentor nuttalli can cause paralysis, which may be fatal, in dogs (Theiler, 1962; Norval & Colborne, 1985).

***Rhipicentor bicornis* Nuttall & Warburton, 1908**

Species diagnosis: Theiler (1961). Nymph unknown.

Hosts: Adults parasitize domestic dogs, and sometimes cattle. Wild hosts are primarily Carnivora, including the bat-eared fox, *Otocyon megalotis*, and jackal, *Canis* sp. (Canidae); genets, *Genetta* sp. (Viverridae), and the cats, especially the cheetah, *Acinonyx jubatus*; leopard, *Panthera pardus*, and lion, *Panthera leo*, also 2 smaller species, the serval, *Felis serval*, and African wild cat, *Felis lybica* (Felidae). It has been recorded once from the eland, *Taurotragus oryx* (Artiodactyla, Bovidae). Hosts of the immature stages unknown.

Distribution: South Africa, Transvaal, in the Waterberg and at Onderstepoort, and Namibia, where it is widely distributed in the northern part of the country, and is also recorded in the south from Bethanien District. Extralimitally it is widely distributed in Central Africa.

***Rhipicentor nuttalli* Cooper & Robinson, 1908**

Species diagnosis: Theiler (1961). Nymph undescribed.

Hosts: Adults are recorded from domestic dogs, and a donkey. The most commonly recorded wild hosts are the South African hedgehog, *Atelerix frontalis* (Insectivora, Erinaceidae) and porcupine, *Hystrix africaeaustralis* (Rodentia, Hystricidae). It has also been found on a genet, *Genetta* sp. (Carnivora, Viverridae); brown hyaena, *Hyaena brunnea*, and

“hyaena” (Hyaenidae); and cheetah, *Acinonyx jubatus*; leopard, *Panthera pardus*; lion, *Panthera leo*, and “wild cat” (Felidae). Hosts of the immature stages are unknown.

Distribution: South Africa, Transvaal, in a belt stretching from the Waterberg southwards to the Pretoria area and beyond as far as Potchefstroom and Heidelberg Districts; Cape Province, in Richmond, Hanover, Grahamstown and especially Clanwilliam Districts; Namibia, at various places from Windhoek northwards, and Botswana at Nokanen, Ngamiland; Lobatse and in the Tati Concession. It occurs extralimitally in Zimbabwe.

GENUS *RHIPICEPHALUS* KOCH, 1844

Generic characteristics:

- (a) Most species inornate but 4 ornate, i.e. with a colour pattern on their scutum (*maculatus* and, in East Africa, *pulchellus*, *humeralis*, and *dux*)
- (b) Hypostome and palps short
- (c) Basis capituli usually hexagonal
- (d) Eyes present
- (e) Festoons present
- (f) Adanal plates in the male present

This is the largest genus in southern Africa, comprising 28 species plus one entity that has yet to be described and several others whose taxonomic status is at present uncertain. Some of the information presented below is based on my re-examinations of specimens in the Onderstepoort Tick Collection. I. G. Horak (personal communications) has also kindly allowed me to incorporate some of his unpublished data on the following species: *arnoldi*; *capensis sensu stricto*; *follis*; *glabroscutatum*; *lounsburyi*; *oculatus*; a new species near *oculatus*, and *punctatus*.

It presents many taxonomic problems, especially to the beginner. As early as 1912 Cecil Warburton, in the opening paragraph of one of the most perceptive papers ever published on this genus, summarized the situation thus: “The identification of species of *Rhipicephalus* is likely to give more trouble than is the case with any other genus of Ixodidae, for while, on the one hand, there are few species which depart greatly from the general type, on the other hand the range of variation within the species is extremely great”. Often this variability is dependant on nutrition, as was shown by Warburton’s colleagues G. H. F. Nuttall (1913) and N. Cunliffe (1914) in their classic studies on *Rhipicephalus appendiculatus* and *R. sanguineus* respectively. Recently it has also been shown that, under laboratory conditions, hybridization between certain closely related species can occur (Zivkovic, Pegram, Jongejan & Mwase, 1986; Wouters, 1989; Wouters, Berkvens & Gomes, 1989).

Considerable advances in our knowledge of this genus were made by Gertrud Theiler. In 1949 she produced a valuable review of many little known rhipicephalids, then in 1953 she and Britha Robinson published a detailed study of 6 of the lesser known species. Some of Theiler’s taxonomic decisions are not now regarded as valid, but it must be remembered that when she did much of her early taxonomic research it was difficult, if not impossible, for her to study the numerous type specimens that had been deposited in museum collections in Britain and Europe. This factor undoubtedly contributed largely to the erroneous conclusions that she sometimes reached. In later years she herself queried

several of her earlier decisions, either in papers or in discussions with the writer.

During the 1940s F. Zumpt also published a series of papers in which he discussed many *Rhipicephalus* spp. His interpretation of interspecific relationships was, however, seriously hampered by the fact that he did not include the immature stages in his studies.

In recent years the use of scanning electron microscopy has greatly facilitated our understanding of this genus.

Several species of *Rhipicephalus* are known vectors of pathogens affecting domestic and wild animals, and to a lesser extent man, in Africa. By far the most important of these is the brown ear tick, *R. appendiculatus*, which is the primary vector of *Theileria parva parva*, the protozoon causing East Coast fever of cattle in East and Central Africa. It can also transmit other pathogens, including *Theileria parva bovis*, *Theileria parva lawrencei*, *Theileria taurotragi*, *Ehrlichia bovis*, and Nairobi sheep disease virus, as well as *Rickettsia conori*, the causative agent of tick-bite fever in man (De Vos, 1981). Other vectors of the *Theileria* spp. affecting cattle are *R. zambeziensis*, which can transmit all the *T. parva* group parasites plus *T. taurotragi* (Lawrence, Norval & Uilenberg, 1983); *R. duttoni*, which transmits *T. parva lawrencei* in Angola (Da Graça & Serrano, 1971), and *R. evertsi evertsi*, which can sometimes transmit *T. parva parva*, though it is apparently not a very efficient vector of this organism.

Recently *R. simus*, which was shown to be capable of transmitting *Anaplasma marginale* by Sir Arnold Theiler, has also proved to be a vector of *Anaplasma centrale* (Potgieter & Van Rensburg, 1987), and *R. evertsi evertsi*, long known to carry *Babesia equi*, has now been established as a vector of *Babesia caballi* (De Waal & Potgieter, 1987). *R. sanguineus*, the most cosmopolitan member of the genus, is a vector of *Babesia canis*, *Ehrlichia canis*, and *Hepatozoon canis* in dogs, as well as *R. conori* in man.

Some *Rhipicephalus* spp. are known to secrete toxins that can have deleterious effects on their hosts. For example, cattle that are heavily infested with *R. appendiculatus* may develop a syndrome known as brown ear tick toxicosis. Other species have been associated with paralysis of animals and man. Among these are *R. evertsi evertsi*, which sometimes causes spring lamb paralysis, and *R. simus*, which has occasionally been reported as causing paralysis in man. Recently Fourie, Horak & Marais (1988a) described cases of paralysis in Angora goats caused by an *R. pravus*-like tick that is now believed to be *R. punctatus* (see below).

***Rhipicephalus appendiculatus* Neumann, 1901**

Species diagnosis: Walker, Norval & Corwin (1981).

Hosts: All stages often feed on the same animals, and this tick has an extremely wide host range. It will parasitize all species of domestic animals, especially cattle, on which very large infestations may occur. Sheep and goats are of secondary importance only. Dogs and cats are rarely infested. It has also been recorded from numerous species of wild animals. Its preferred hosts are Artiodactyla; many species carry all stages but the smaller antelopes are usually infested by the immature stages only. It has been found less commonly on Primates (usually small infestations only); Carnivora (mostly immature stages on the smaller species of Canidae, Viverridae and Felidae, and adults on the Hyaenidae and larger

Felidae); Proboscidea (occasional adult ticks); Perisodactyla (especially Equidae); and Rodentia (a few species are recorded as hosts of the immatures, but sometimes all stages are present on the Hystricidae). Immature stages only are recorded from various species of Insectivora, Hyracoidea, the smaller species of Rodentia; the Lagomorpha, Leporidae, and birds (Aves), including both non-passerines and passerines (Theiler, 1962; Norval, Walker & Colborne, 1982).

Distribution: In southern Africa *R. appendiculatus* occurs from south-eastern Botswana eastwards across the Limpopo River, through the Transvaal Bushveld south of the Soutpansberg and into parts of the Lowveld, including the southern end of the Kruger National Park. It also occurs in a salient of the Bushveld extending into the northern end of the Kruger National Park at Pafuri, near the Zimbabwe and Mozambique borders. From the Transvaal Lowveld its distribution extends southwards through Swaziland, most parts of Natal below c. 1500 m, the Transkei, and the coastal areas of the eastern Cape as far as Port Elizabeth. Thus it is present in various types of bushland and thornveld, but not in open grassland (Lessard, L'Eplattenier, Norval, Kundert, Dolan, Croze, Walker, Irvin & Perry, 1990).

The distribution of *R. appendiculatus* as shown by Theiler (1949c) and Howell *et al.* (1978, Map 7) is in part incorrect. This tick is not now thought to occur in the north-western and northern Transvaal, between the Soutpansberg and the Limpopo River, where it was in the past confused with *R. zambeziensis*. It is sympatric with *R. zambeziensis* in parts of the Transvaal. In the Fauresmith area the tick referred to by Theiler (1949c) as a separate "variety or subspecies of *R. appendiculatus*" has now been identified as *R. punctatus* (see below). Furthermore, *R. appendiculatus* does not occur in the coastal areas of Cape Province, between Port Elizabeth and Cape Town, where it was confused with *R. nitens* (see below).

Extralimitally *R. appendiculatus* is widely distributed in East and Central Africa (Lessard *et al.*, 1990).

***Rhipicephalus arnoldi* Theiler & Zumpt, 1949**

Species diagnosis: Theiler & Zumpt (1949).

Hosts: All stages prefer hares, especially red hares, *Pronolagus* spp., (sometimes called red rock rabbits) (Horak & Fourie, 1986), occasionally also the scrub hare, *Lepus saxatilis*, and Cape hare, *Lepus capensis* (Lagomorpha, Leporidae). Immature stages only have been collected from the caracal, *Felis caracal* (Carnivora, Felidae) (Horak *et al.*, 1987c); rock dassie, *Procavia capensis* (Hyracoidea) (Horak & Fourie, 1986), also the striped mouse, *Rhabdomys pumilio*, and a "field mouse" (Rodentia, Muridae).

Distribution: South Africa, Transvaal, at Makapan Caves, Naboomspruit, Onderstepoort and Potchefstroom; Orange Free State, Fauresmith; and Cape Province, at various points in Richmond, Murraysburg, Graaff-Reinet and Cradock Districts. Extralimitally it has been recorded in Zimbabwe. [Records from the Sudan (Hoogstraal, 1956) are now considered incorrect].

***Rhipicephalus capensis* group**

Theiler (1962), in her review of the distribution of *R. capensis* in South Africa, commented that this specific name 'appears to be a catchall for "capensis-

like" ticks.....' Subsequent studies have confirmed this. In southern Africa the group at present comprises 3 species: *R. capensis sensu stricto*, *R. follis sensu stricto*, and *R. gertrudae*. The status of at least one other entity occurring in Namibia, identified merely as a member of this group, has yet to be determined.

Earlier Theiler (1950a) reviewed and mapped the distribution of the ticks she was then identifying as *R. capensis*. Unfortunately many of the collections on which her paper was based are no longer available. The accounts given below of the 3 currently recognized species in this group are based on existing specimens only.

***Rhipicephalus capensis* Koch, 1844**

Species diagnosis: Feldman-Muhsam (1960). Immature stages of this species *sensu stricto* undescribed.

Hosts: Adults feed on cattle and horses. The only definite wild animals hosts recorded to date are the mountain zebra, *Equus zebra* (Perissodactyla, Equidae) and the eland, *Taurotragus oryx* (Artiodactyla, Bovidae). This host list is undoubtedly very incomplete. Hosts of the immature stages of this particular species have not as yet been recorded, although Theiler (1962) lists various rodents as hosts of immature *R. capensis sensu lato*.

Distribution: It is recorded in South Africa only, in Cape Province. With one exception, in eastern Cape Province, Cradock District, Mountain Zebra National Park, all records are from western Cape Province, in Namakwaland, Vanrhynsdorp, Clanwilliam, Hopefield, Simonstown and Robertson Districts.

***Rhipicephalus deltoideus* Neuman, 1910**

Species diagnosis: Theiler (1949a). The type collection from Lesotho, originally comprising 1 ♂, 3 ♀♀, is the only one recorded from southern Africa. Of this collection only 1 ♀ syntype (Neumann No. 1721, Nuttall Collection No. 2894, RML 111767) now remains, deposited in the British Museum (Natural History), London (Keirans, 1985). According to Gertrud Theiler (personal communication), the types from the Neumann Collection were lost in transit between South Africa and France after they had been sent to her on loan.

Host: Not recorded.

Distribution: Lesotho, precise locality not recorded, but said to be at an altitude of 2 135 m.

***Rhipicephalus distinctus* Bedford, 1929**

Species diagnosis: Theiler (1949a). Immature stages undescribed.

Hosts: All stages prefer the rock dassie, *Procavia capensis* (Horak & Fourie, 1986) and "dassies" (species not recorded) (Hyracoidea). It has not as yet been collected from the tree dassie, *Dendrohyrax arboreus*, in South Africa. One collection of adults from a klipspringer, *Oreotragus oreotragus* (Artiodactyla, Bovidae), listed as *R. simpsoni* by Baker & Keep (1970), has proved on re-examination to be *R. distinctus*. A few immature specimens have been recorded from caracal, *Felis caracal* (Carnivora, Felidae) (Horak *et al.* 1987c). The record in Theiler (1962) from the bushpig, *Potamochoerus porcus* (Artiodactyla, Suidae), is based on an incorrect identification.

Distribution: In South Africa, Transvaal, recorded from Pietersburg, Onderstepoort, Potchefstroom

and Schoemansdrift; Natal, Hluhluwe/Umfolozu complex (Baker & Keep, 1970, as *R. simpsoni*) and Weenen District at Muden; Orange Free State, at Fauresmith; Cape Province, at various points in the north-eastern and eastern parts of the province, also in the western Cape at Hout Bay; Namibia, mostly north of Windhoek, at Opuwo (formerly Ohopoho), Sesfontein, Kamanjab, Kalkveld, Omaruru, Okahanja, Osona and Otjongombe, also south-west of Windhoek at Naukluft; and Botswana, only in the east at Tshesebe and Kanye. Widely distributed extralimitally, mostly in East and Central Africa.

***Rhipicephalus duttoni* Neumann, 1907**

Species diagnosis: Theiler (1949a). Immature stages undescribed.

Hosts: The adults apparently prefer ungulates (Artiodactyla, Bovidae), though few data are available. In southern Africa the sole recorded host is the black-faced impala, *Aepyceros melampus petersi*. In other parts of its range this tick occurs on most species of domestic animals (Sousa Dias, 1950).

Distribution: In southern Africa it is recorded only in north-western Namibia, Kaokoland 1, at Swartbooisdrift on the Cunene River and at Enyandi (Heloise Heyne, unpublished data). [The records in Howard (1908) from the Transvaal, and from Mozambique, based on a few specimens only, cannot be checked because the ticks no longer exist; these records are thought to be incorrect]. It occurs extralimitally in Angola and Zaire.

***Rhipicephalus evertsi evertsi* Neumann, 1897**

Species diagnosis: Theiler (1943b); Hoogstraal (1956); Howell *et al.* (1978).

Hosts: All stages frequently feed on the same hosts. This species parasitizes all domestic herbivores, especially horses, donkeys and cattle, but rarely dogs, and not cats. Amongst wild animals its preferred hosts include Burchell's zebra, *Equus burchellii* (Perissodactyla, Equidae) (Horak *et al.*, 1984a), and other ungulates (Artiodactyla). It has also been recorded from a Primate, the chacma baboon, *Papio ursinus*; occasionally from the large cats (Carnivora, Felidae); from an elephant, *Loxodonta africana* (Proboscidea) and frequently from wild hares, *Lepus* spp. (Lagomorpha, Leporidae). The immature stages have occasionally been collected from various species of Insectivora; some of the smaller Carnivora (Canidae, Viverridae and Felidae) (Horak *et al.*, 1987c); Hyracoidea and Rodentia, also various birds (Aves), both non-passerines and passerines.

Distribution: In South Africa *R. evertsi evertsi* occurs throughout the Transvaal; Swaziland; Natal and Zululand; the Transkei; the Orange Free State; and in Cape Province in the north-eastern and eastern border districts, all along the southern coastal strip and up the west coast as far as Vanrhynsdorp. Theiler (1950b) also recorded 2 populations further north in Namakwaland, though in general she considered this district to be free of the red-legged tick. It is not known whether these isolated populations still exist. In Namibia *R. evertsi evertsi* is present in the moister northern part of the country and throughout the Caprivi strip. In Botswana it has been recorded at many places in the northern, eastern and southern parts of the country but more rarely in the western Kgalagadi (Walker *et al.*, 1978; Paine, 1982). Theiler (1950b) noted that its spread is apparently limited by increasing aridity, the critical rainfall level being about 250 mm. Extralimitally it is

one of the most widely distributed species in the Afrotropical region.

***Rhipicephalus evertsi mimeticus* Dönitz, 1910**

Species diagnosis: Sousa Dias (1950). This subspecies has banded legs, so can easily be mistaken for a *Hyalomma* by the unwary. Otherwise it closely resembles *R. e. evertsi* morphologically. Immature stages undescribed.

Hosts: All stages frequently feed on the same animals. It apparently parasitizes the same hosts as *R. e. evertsi*, i.e. all the domestic herbivores and, amongst wild animals, Hartmann's mountain zebra, *Equus zebra hartmannae* (Perissodactyla, Equidae) (Horak, Biggs & Reinecke, 1984b), and various species of Artiodactyla. It is also recorded from the lion, *Panthera leo* (Carnivora, Felidae).

Distribution: Namibia, mostly north of the Tropic of Capricorn (Horak *et al.*, 1984b; Heloise Heyne, unpublished data, 1989), and western and southern Botswana (Walker *et al.*, 1978; Paine, 1982). Extraliminally it occurs in Angola and western Zaïre.

***Rhipicephalus follis* Dönitz, 1910**

Species diagnosis: Theiler (1949a). [The description of *R. follis* by Theiler & Robinson (1953b) refers to another species: see *R. lounsburyi*]. In the past this tick has frequently been misidentified as *R. capensis* (Theiler, 1950a, 1962). Immature stages undescribed.

Hosts: The adults feed almost exclusively on the large herbivores. Amongst domestic animals cattle are the most frequently recorded hosts. Most wild hosts are antelopes, especially the eland, *Taurotragus oryx* (Artiodactyla, Bovidae). Adults have also been recorded once from a cheetah, *Acinonyx jubatus*, and larvae from the caracal, *Felis caracal* (Carnivora, Felidae) (Horak *et al.*, 1987c). The preferred hosts of the immature stages are, however, rodents (Rodentia, Muridae).

Distribution: Present indications are that *R. follis* occurs only in South Africa, where it is widely distributed in the south-eastern Transvaal; central Orange Free State, Natal, and Cape Province, primarily in the south-east but with a few records from the southern coastal areas [Horak *et al.*, 1986a, 1987c, both as *Rhipicephalus* sp. (near *R. capensis*); Horak *et al.*, 1989; J. B. Walker, unpublished data].

***Rhipicephalus gertrudae* Feldman-Muhsam, 1960.**

Species diagnosis: Feldman-Muhsam (1960). This tick was included under *R. capensis* by Theiler (1950a, 1962). Biggs & Langenhoven (1984), who studied the seasonal incidence of ticks on cattle on a farm in Windhoek District, Namibia, were unable to distinguish *R. gertrudae* consistently from another *R. capensis* group tick occurring in the same area. Immature stages undescribed.

Hosts: The adults are almost exclusively parasites of the larger herbivores. Amongst domestic animals this species has been recorded from cattle, sheep, goats, horses and a donkey. Wild animal hosts include the mountain zebra, *Equus zebra* (Perissodactyla, Equidae), various large antelope species (Artiodactyla, Bovidae), and the porcupine, *Hystrix africae australis* (J. B. Walker, unpublished data). Hosts of the immature stages have not as yet been recorded but are likely to be small mammals, probably rodents.

Distribution: In South Africa *R. gertrudae* is

widely distributed in Cape Province, including parts of the Karoo (Williston and Fraserburg Districts). In the east it extends into the southern and central Orange Free State, and in the west northwards through Namakwaland into Namibia (J. B. Walker, unpublished data; Heloise Heyne, unpublished data). It is not thought to occur extraliminally.

***Rhipicephalus glabroscutatum* Du Toit, 1941**

Species diagnosis: Du Toit (1941)

Hosts: All stages feed on goats, and to a lesser extent on sheep and cattle (MacIvor, 1985). Their wild animal hosts are primarily various large and small antelopes, especially browsers such as kudu, *Tragelaphus strepsiceros*, and eland, *Taurotragus oryx* (Artiodactyla, Bovidae), plus the Cape mountain zebra, *Equus zebra zebra* (Perissodactyla, Equidae) (Young *et al.*, 1973; MacIvor 1985, Horak *et al.*, 1986a). The immature stages also feed on the scrub hare, *Lepus saxatilis* (Lagomorpha, Leporidae) (Horak & Knight, 1986).

Distribution: This species is recorded only in South Africa, Cape Province, primarily in the south-east but with a few records from the central and southern parts of the province (MacIvor, 1985), also from the west coast at Langebaan, Hopefield District.

***Rhipicephalus kochi* Dönitz, 1905**

Species diagnosis: Clifford, Walker & Keirans (1983). [Note that Yeoman & Walker (1967) resurrected the name *Rhipicephalus jeanneli* Neumann, 1913 for the East African highland tick listed as *R. kochi* in Theiler (1962)].

Hosts: In South Africa adults and nymphae have been recorded from kudu, *Tragelaphus strepsiceros*; nyala, *Tragelaphus angasii*, and bushbuck, *Tragelaphus scriptus* (Artiodactyla, Bovidae) (Horak *et al.*, 1983b), also the warthog, *Phacochoerus aethiopicus* (Suidae) (Horak, Boomker, De Vos & Potgieter, 1988b), and scrub hare, *Lepus saxatilis* (Lagomorpha, Leporidae). Extraliminally it has been recorded from a very wide range of both domestic and wild animals, mostly Artiodactyla, Bovidae and Suidae, but including various species of Carnivora, Felidae; Proboscidea; Perissodactyla, Rhinocerotidae and Equidae; Rodentia, Hystricidae; Lagomorpha, and Macroscelidea, and even a ground-feeding bird, the black-bellied korhaan, *Lissotis melanogaster* (Aves) (Clifford *et al.*, 1983).

Distribution: In South Africa *R. kochi* has been found at Pafuri, at the northern end of the Kruger National Park (Horak *et al.*, 1983b, 1988b), and Ndumu, in KwaZulu. Extraliminally it is widely distributed in East and Central Africa.

***Rhipicephalus longiceps* Warburton, 1912**

Species diagnosis: Theiler (1949a). Immature stages unknown.

Hosts: This rare tick has been recorded once from cattle. Wild animal hosts all belong to the Artiodactyla: the klipspringer, *Oreotragus oreotragus*, and gemsbok, *Oryx gazella* (Bovidae), also warthog, *Phacochoerus aethiopicus* (Suidae) (Horak, Biggs, Hanssen & Hanssen, 1983a).

Distribution: Namibia, on the farm "Okonjima" (20° 51' S, 16° 40' E); at Omandumba, Omaruru; Okahandja (Santos Dias, 1958); near Sukkes, and on the farm "Lichtenstein-Süd" (22° 51' S, 17° 01' E), near Windhoek. Extraliminally it occurs in Angola.

***Rhipicephalus lounsburyi* Walker, 1990**

Species diagnosis: Walker (1990). It was originally described as *Rhipicephalus follis* by Theiler & Robinson (1953b).

Hosts: The only domestic animals recorded thus far are sheep. It has been collected from the following wild ungulates (Artiodactyla, Bovidae): bontebok, *Damaliscus dorcas*, and grey rhebok, *Pelea capreolus* (Horak *et al.*, 1986b), also the black wildebeest, *Connochaetes gnou*; eland, *Taurotragus oryx*, and mountain reedbeek, *Redunca fulvorufula*. The hosts of the immature stages are still unknown.

Distribution: It has been recorded only in South Africa, most commonly in eastern Cape Province, especially in the mountainous areas of Barkly East, Dordrecht and Cradock Districts. In western Cape Province it has been found near Swellendam (Horak *et al.*, 1986b) and between Clanwilliam and Graafwater, and once in Natal, in the Impendle area.

***Rhipicephalus lunulatus* Neumann, 1907**

Species diagnosis: Walker, Keirans, Pegram & Clifford (1988). It was synonymized with *Rhipicephalus tricuspis* by Theiler (1949a, 1962), but this finding was never universally accepted.

Hosts: The adults will parasitize almost all species of domestic animals, especially cattle and often dogs. Amongst wild animals *R. lunulatus* has an extremely wide host range. The commonest hosts include the African buffalo, *Syncerus caffer*, and many species of large and small antelopes (Artiodactyla, Bovidae), also the bushpig, *Potamochoerus porcus*, and warthog, *Phacochoerus aethiopicus* (Suidae). It has been collected quite frequently from various carnivores (Canidae, Viverridae and Felidae). A few records, probably representing accidental records only, exist from other mammals, including man, and 2 from water birds (Aves). Hosts of the immature stages are unknown.

Distribution: In South Africa it occurs in the northern and eastern Transvaal and Natal, and in Botswana mainly in and around the Okavango delta, also in the east at Tshesebe. Extraliminally it is very widely distributed in the Afrotropical region.

***Rhipicephalus maculatus* Neumann, 1901**

Species diagnosis: Theiler & Robinson (1953b).

Hosts: All stages often feed on the same hosts. This tick has sometimes been collected from cattle, and very occasionally from sheep and goats, but not from other domestic animals. The adults, and sometimes the immature stages, occur on many of the larger game animals, e.g. the large cats and hyaenas (Carnivora, Felidae and Hyaenidae); the elephant, *Loxodonta africana* (Proboscidea); both species of rhinoceros, *Diceros bicornis* and *Ceratotherium simum*, and Burchell's zebra, *Equus burchellii* (Perissodactyla, Rhinocerotidae and Equidae); the buffalo, *Syncerus caffer*, and various large antelopes (Artiodactyla, Bovidae), and the wild pigs (Suidae) (Baker & Keep, 1970; Horak *et al.*, 1983b). The immature stages have been collected from some of the smaller carnivores, including the civet, *Civettictis civetta* (Viverridae) and serval, *Felis serval* (Felidae); and the smaller antelopes, impala, *Aepyceros melampus*, and various duikers (Baker & Keep, 1970); also the rock dassie, *Procavia capensis* (Hyracoidea), and scrub hare, *Lepus saxatilis* (Lagomorpha, Leporidae).

Distribution: South Africa, in the coastal areas of northern Natal, often in the same places as *R. muel-*

lensi. It occurs extraliminally in eastern Africa, mainly in the coastal regions of Mozambique, Tanzania and Kenya.

***Rhipicephalus muelhensi* Zumpt, 1943**

Species diagnosis: Salisbury (1959).

Hosts: All stages often feed on the same hosts. This tick sometimes occurs, in very small numbers, on cattle, and very occasionally on sheep and goats. It is commonest on various species of large and small wild antelopes, especially nyala, *Tragelaphus angasi*, and bushbuck, *Tragelaphus scriptus* (Artiodactyla, Bovidae) (Horak *et al.*, 1983b, 1988a), and on the wild pigs (Suidae). It has also been recorded from various small carnivores (Canidae and Mustelidae); the elephant, *Loxodonta africana* (Proboscidea), both species of rhinoceros, *Diceros bicornis* and *Ceratotherium simum*, and Burchell's zebra, *Equus burchellii* (Perissodactyla, Rhinocerotidae and Equidae) (Baker & Keep, 1970).

Distribution: South Africa, in the coastal areas of northern Natal, often in the same places as *R. maculatus*. It occurs extraliminally in the coastal areas of eastern Africa.

***Rhipicephalus neumanni* Walker, 1990**

Species diagnosis: Walker (1990).

Hosts: Primarily sheep, and to a lesser extent goats. It has been found once on a horse, and once on a gemsbok, *Oryx gazella* (Artiodactyla, Bovidae) (J.B. Walker, unpublished data).

Distribution: South Africa, Cape Province, in scattered localities in the Karoo, and Namibia, mainly in Bethanien and Keetmanshoop Districts, plus one record from north of Windhoek at Omandumba, Omaruru (J.B. Walker, unpublished data). It is not known to occur extraliminally.

***Rhipicephalus nitens* Neumann, 1904**

Species diagnosis: Neumann (1904). Immature stages undescribed. It was listed by Zumpt (1949) as a synonym of *R. appendiculatus*. Subsequently Theiler (1962) commented: "Present day findings tend to show that this is a valid species". Keirans (1985) also regarded it as valid.

Hosts: All stages will feed on the same host (Horak *et al.*, 1986b). Amongst domestic animals it strongly favours sheep, sometimes feeds on goats, and occasionally occurs on dogs (Horak *et al.*, 1987c). Known wild animal hosts are mostly antelopes: bontebok, *Damaliscus dorcas dorcas*; springbuck, *Antidorcas marsupialis*, and grey rhebok, *Pelea capreolus* (Artiodactyla, Bovidae) (Horak, Meltzer & De Vos, 1982a; Horak, Brown, Boomker, De Vos & Van Zyl, 1982b; Horak, De Vos & De Klerk, 1982c; Horak *et al.*, 1986b). Others include the mountain zebra, *Equus zebra* (Perissodactyla, Equidae) (J.B. Walker, unpublished data) and especially the scrub hare, *Lepus saxatilis* (Lagomorpha, Leporidae) (Horak *et al.*, 1986b).

Distribution: South Africa, Cape Province, mainly in the southern coastal strip from Port Elizabeth westwards, in association with Cape shrubland (*fynbos*) vegetation (White, 1983). It has also been found, again in association with *fynbos*, between Grahamstown and Paterson. Howell *et al.* (1978) erroneously included the distribution zone of *R. nitens* with that of *R. appendiculatus*.

***Rhipicephalus oculatus* Neumann, 1901**

Species diagnosis: Neumann (1901). Immature

stages undescribed. According to C. M. Clifford & J. E. Keirans (personal communication), their examination of the syntype ♂ (Zoological Museum, Berlin 17613) and ♀ (ZMB 17614) of *R. oculatus* from "Damaraland, D.S.W. Afrika" revealed that these ticks do not belong to the same species as the series described under this name (OP 2810) by Theiler & Robinson (1953b). Theiler (1962) listed *R. oculatus* from a wide range of hosts and from various countries in East and Central Africa, though she queried its presence in Kenya, Uganda and Tanzania (formerly Tanganyika). Her records are now known to include at least 3, possibly 4, related species: *R. oculatus sensu stricto*; *R. sp. near oculatus* (see below); *R. pravus* in East Africa (Walker, 1974), and possibly *R. punctatus* in Central and southern Africa. Only host and distribution records presently known to refer to *R. oculatus sensu stricto* are included below.

Hosts: Thus far this species has been recorded virtually exclusively from hares, especially the scrub hare, *Lepus saxatilis*, and sometimes the Cape hare, *Lepus capensis*, and Smith's red hare, *Pronolagus rupestris* (Lagomorpha, Leporidae). R. H. N. Smithers (personal communication) commented that "*Lepus timidus*", from which the Damaraland types were recorded by Neumann (1901), was probably *L. capensis*, though it could possibly have been *L. saxatilis*.

Distribution: South Africa, Orange Free State, Fauresmith, and Cape Province, from scattered localities in the Karoo and eastern Cape Province; Namibia, between Windhoek and Walvis Bay, also in Damaraland. It is not known to occur extraliminally.

Rhipicephalus sp. near oculatus

Species diagnosis: Theiler & Robinson (1953b) as *R. oculatus*; see above under *R. oculatus sensu stricto*. Only host and distribution records for this species that have been confirmed recently are listed below.

Hosts: Domestic animal hosts recorded for the adults are most commonly cattle and sheep, sometimes goats, and only occasionally other species. Known wild animal hosts are mostly antelopes, especially gemsbok, *Oryx gazella*, and kudu, *Tragelaphus strepsiceros*, also springbuck, *Antidorcas marsupialis* (Artiodactyla, Bovidae). Only a few records exist from the Cape hare, *Lepus capensis*, and scrub hare, *Lepus saxatilis* (Lagomorpha, Leporidae).

Distribution: In South Africa this species has as yet been recorded only in eastern Cape Province, south of the line from Jansenville—Mountain Zebra National Park—Bucklands farm (33° 05' S, 26° 43' E), north-east of Grahamstown. In Namibia it is widely distributed, especially south of Windhoek.

***Rhipicephalus punctatus* Warburton, 1912.**

Species diagnosis: Clifford *et al.* (1983.) It is one of the 3 closely related species included under the name *Rhipicephalus pravus* Dönitz, 1910 in Theiler (1962): *R. pravus sensu stricto*, which occurs in eastern Africa; *R. kochi sensu stricto*, whose range extends from eastern to southern Africa (see above), and *R. punctatus*, which is now thought to range from eastern to southern Africa. It features in the southern African literature as an atypical strain of *R. appendiculatus* occurring in the Fauresmith area (Theiler, 1949c); as *R. pravus* (Paine, 1982), and as a *Rhipice-*

phalus pravus-like tick (Fourie, Horak & Marais, 1988a, b).

Hosts: In South Africa adults are recorded from cattle, sheep, goats, and various wild ungulates, including giraffe, *Giraffa camelopardalis*; tsessebe, *Damaliscus lunatus*; steenbok, *Raphicerus campestris*; impala, *Aepyceros melampus*; gemsbok, *Oryx gazella*, and eland, *Taurotragus oryx* (Artiodactyla, Giraffidae and Bovidae). All stages feed on scrub hares, *Lepus saxatilis* (Lagomorpha, Leporidae) and the immature stages only on rock elephant shrews, *Elephantulus myurus* (Macroscelideae).

Distribution: In South Africa *R. punctatus* is widely distributed in the western, northern and north-eastern Transvaal, plus the southern Orange Free State and adjacent districts south of the Orange River in north-eastern Cape Province. In Botswana it is recorded in the eastern parts of Central and Ghanzi Districts. Extraliminally it occurs in parts of East and Central Africa.

***Rhipicephalus sanguineus* (Latreille, 1806)**

Species diagnosis: Pegram, Keirans, Clifford & Walker, 1987b). These authors, who re-examined numerous collections originally identified as *R. sanguineus*, found that many records listed under this name by Theiler (1962) refer to *R. turanicus*, a species not then known to occur in the Afrotropical region (see below).

Hosts: It is primarily a parasite of dogs, and is only occasionally found on other hosts. If not controlled it will readily establish itself and breed in kennels (Horak, 1982) and human habitations.

Distribution: Theiler (1962) considers that in South Africa *R. sanguineus* "is prevalent throughout, though somewhat rare in the drier parts". This is probably true but it requires confirmation. The only specimens present in the Onderstepoort Collection are from the Pretoria area and Johannesburg. In Namibia it is widely distributed (Heloise Heyne, unpublished data). It is the only cosmopolitan species in this genus.

***Rhipicephalus simpsoni* Nuttall, 1910**

Species diagnosis: Adults (Theiler, 1949a); nymph (Clifford & Anastos, 1964); larva undescribed.

Hosts: A specific parasite of the greater cane rat, *Thryonomys swinderianus* (Rodentia, Thryonomyidae). Other hosts are rare. The record in Baker & Keep (1970) from the klipspringer, *Oreotragus oreotragus* (Artiodactyla, Bovidae), was based on a misidentification (see above under *R. distinctus*).

Distribution: South Africa, Transvaal, Nylstroom and Komatipoort, and KwaZulu, Ndumu. It is widely distributed extraliminally.

***Rhipicephalus simus* Koch, 1844**

Species diagnosis: Pegram, Walker, Clifford & Keirans (1987c). At least 3 species were included under this name by Theiler (1962), i.e. *R. simus sensu stricto* (southern and central Africa); *R. praetextatus* (eastern Africa), and *R. muhsamae* (western Africa). The precise boundaries between the ranges of these species have not as yet been determined.

Hosts: Adults feed readily on cattle and dogs but apparently rarely on other domestic animals. Adults have also been recorded from many wild animals, especially Carnivora (Canidae, Viverridae, Protelidae, Hyanidae and Felidae); Perissodactyla, particularly Burchell's zebra, *Equus burchellii* (Equidae); Artiodactyla, especially the warthog, *Phacochoerus*

aethiopicus (Suidae), and the larger species of Bovidae, particularly the buffalo, *Syncerus caffer*, and Rodentia, primarily the porcupine, *Hystrix africaeaustralis* (Hystricidae). Other recorded hosts include Insectivora (Erinaceidae, the southern African hedgehog, *Atelerix frontalis*); Tubulidentata (the aardvark, *Orycteropus afer*) and Pholidota (the pangolin, *Manis temminckii*) (Norval & Mason, 1981; Horak *et al.*, 1983b, 1984b, 1987c, 1988b). The immature stages parasitize various species of rats and mice (Rodentia, Muridae).

Distribution: In the absence of evidence to the contrary it has been assumed that the South African records of *R. simus* given by Theiler (1962) refer to this species *sensu stricto*. She indicated that it is prevalent in the north-eastern and eastern Transvaal, and in Marico, Brits and Pretoria Districts, but is either sparsely distributed or absent elsewhere in this province. It is also prevalent in Swaziland, much of Natal, and in the coastal districts of the Transkei, Ciskei and the eastern Cape as far as Port Elizabeth. There are scattered records from parts of the Karoo and western Cape but *R. simus* has not been recorded from much of western and northern Cape Province, the inland districts of the eastern Cape nor the Orange Free State. In Namibia this species is recorded from scattered localities, mostly north of Windhoek, and in Botswana mainly from the eastern part of the country and from Ngamiland. It also occurs extraliminally.

***Rhipicephalus sulcatus* Neumann, 1908**

Species diagnosis: Pegram, Clifford, Walker & Keirans (1987a). Only records confirmed by these authors are included below.

Hosts: The commonest recorded hosts of the adults are dogs and hares, *Lepus* spp. (Lagomorpha, Leporidae). Adults are also listed from cattle; various wild carnivores (Carnivora, Canidae, Viverridae and Felidae) and a few antelopes (Artiodactyla, Bovidae) (Pegram *et al.*, 1987a). The hosts of the immature stages are unknown.

Distribution: South Africa, "Masekwa" [presumably Masekwaspoort (22° 53' S, 29° 53' E)] and Botswana, Sekoma Pan. It is widely distributed extraliminally.

***Rhipicephalus theileri* Bedford & Hewitt, 1925**

Species diagnosis: Theiler (1949a). Immature stages undescribed.

Hosts: Primarily a group of small mammals that often inhabit the same burrow systems: the suricate, *Suricata suricatta*, and yellow mongoose, *Cynictis penicillata* (Carnivora, Viverridae), plus the ground squirrel, *Xerus inauris*, (Rodentia, Sciuridae). It also parasitizes the tree squirrel, *Paraxerus cepapi*. It is occasionally recorded from other hosts (Theiler, 1962).

Distribution: South Africa, Transvaal, in the Messina, Naboomspruit and Bloemhof areas, plus various places in the Orange Free State and in the eastern and north-western Cape Province; Namibia, from scattered localities in the central part of the country, ranging from Outjo and Grootfontein Districts southwards to Mariental (formerly Gibeon), and Botswana, Ngamiland, at Toteng and Shoshong. It is not known to occur extraliminally.

***Rhipicephalus tricuspis* Dönitz, 1906**

Species diagnosis: Walker *et al.* (1988). Theiler (1949a, 1962) synonymized *R. lunulatus* with this species but her finding was never universally

accepted (see *R. lunulatus*). Only confirmed records are reviewed below.

Hosts: Adults have been collected from cattle, goats and dogs but are recorded more frequently from relatively small wild animals. These include wild antelopes, mostly the smaller species, especially the steenbok, *Raphicerus campestris* (Artiodactyla, Bovidae); hares, *Lepus* spp. (Lagomorpha, Leporidae); the spring hare, *Pedetes capensis* (Rodentia, Pedetidae), and various jackals and other wild canids (Carnivora, Canidae). Hosts of the immature stages are unknown; they are probably small mammals.

Distribution: South Africa, at scattered localities in the Transvaal and north-eastern Cape Province; northern Namibia, in Kavango District, and Botswana, primarily in Ngamiland and in the south-eastern part of the country. It also occurs extraliminally.

***Rhipicephalus turanicus* Pomerantsev, 1936**

Species diagnosis: Pegram *et al.* (1987a). Theiler (1962) did not list this species, and the re-examination of specimens in the Onderstepoort Tick Collection has shown that she included it with *R. sanguineus* (see above).

Hosts: Adults of this species have been recorded from a very wide range of both domestic and wild animals. They occur on cattle, but rarely in large numbers. Norval, Daillecourt & Pegram (1983), who recorded it as a *Rhipicephalus* sp., considered that sheep and goats are the more usual domestic hosts, and their ears may become very heavily infested. Dogs are somewhat less favoured than sheep and goats. Amongst wild animals *R. turanicus* has been collected from hares, *Lepus* spp. (Lagomorpha, Leporidae); many species of carnivores (Carnivora, Canidae, Viverridae and Felidae); various ungulates (Perissodactyla and Artiodactyla), and sundry ground-feeding birds (Aves). Ostriches (*Struthio camelus*) may be infested by large numbers of this tick. Hosts of the immature stages unknown.

Distribution: South Africa, Transvaal, from scattered localities, and Natal, Bergville; northern Namibia, from Etosha National Park and Grootfontein. It is widely distributed extraliminally.

***Rhipicephalus zambeziensis* Walker, Norval & Corwin, 1981**

Species diagnosis: Walker *et al.* (1981).

Hosts: A wide range, with all stages often feeding on the same hosts. Domestic animal hosts comprise cattle and, less commonly, horses and dogs. Wild animal hosts include various carnivores, particularly the large cats (Canidae, Viverridae, Hyaenidae and Felidae) and numerous ungulates (mostly Artiodactyla, especially the Suidae and Bovidae) (Norval *et al.*, 1982; Horak, 1987; Horak *et al.*, 1983b, c, 1984b, 1987c, 1988b). Incidental hosts include the antbear, *Orycteropus afer* (Tubulidentata, Orycteropodidae); spring hare, *Pedetes capensis* (Rodentia, Pedetidae), and Cape hare, *Lepus capensis* (Lagomorpha, Leporidae).

Distribution: South Africa, at scattered localities in the Transvaal, particularly at the southern end of the Kruger National Park; northern Namibia, in Kaokoland and Grootfontein Districts, and Botswana, in Ngamiland and in the south-eastern corner of the country (Walker *et al.*, 1978; Norval *et al.*, 1982). It also occurs extraliminally in parts of East and Central Africa.

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