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Clarification of the *Rhipicephalus sanguineus* group (Acari, Ixodoidea, Ixodidae). II. *R. sanguineus* (Latreille, 1806) and related species

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Abstract

In this, our second study on the biosystematics of the *Rhipicephalus sanguineus* group, we consider an additional five species found in the Afrotropical region, namely *R. sanguineus, R. camicasi, R. guilhoni, R. moucheti* and *R. bergeoni.*

Cross-breeding experiments have shown that *R. sanguineus* (Latreille, 1806) *sensu stricto* is genetically distinct from *R. camicasi* Morel, Mouchet & Rodhain, 1976. Further cross-breeding trials confirmed that *R. camicasi* also occurs in Saudi Arabia: a field strain from this country was more productive than a laboratory-reared strain from Egypt. *R. sanguineus,* which parasitises mainly dogs, probably occurs throughout the Afrotropical region. *R. camicasi* parasitises both large and small domestic ruminants and is restricted to the arid and semi-arid lowlands of northeastern Africa and the Arabian peninsula. The larva, nymph, male and female of these two last named species are described with the aid of scanning electron micrographs (SEMs).

The two western African species, *R. guilhoni* Morel & Vassiliades, 1963 and *R. moucheti* Morel, 1964, are accepted as valid members of the *R. sanguineus* group, but we have little material available for critical study. The male and female of *R. guilhoni* are briefly redescribed with the aid of SEMs.

R. bergeoni Morel & Balis, 1976 occurs predominantly on cattle in the wetter highlands and subhighlands of Ethiopia and Sudan. The male and female are briefly described. Current morphological and ecological data suggest that the inclusion of this species in the *R. sanguineus* group is questionable.

Introduction

In our first paper on the clarification of the systematic status of the *Rhipicephalus sanguineus* group in the Afrotropical region (Pegram *et al.*, 1987) we critically reviewed available literature on the species comprising the group. The biosystematic status of *Rhipicephalus sulcatus* Neumann, 1908 and *Rhipicephalus turanicus* Pomerantsev, 1936 was established by intregrated biological and ecological studies and scanning electron microscopy (Pegram *et al.*, 1987). *R. sulcatus* has been shown to be widely distributed in suitable localities in the Afrotropical region. *R. turanicus* is now also thought to be widespread in this region as well as in parts of Europe and Asia.

In this paper we consider the status of *Rhipicephalus sanguineus* (Latreille, 1806) *sensu stricto* and of three other species that occur in the Afrotropical region: *Rhipicephalus camicasi* Morel, Mouchet & Rodhain, 1976; *Rhipicephalus guilhoni* Morel & Vassiliades, 1963; and *Rhipicephalus* *moucheti* Morel, 1964. We also briefly describe and discuss *Rhipicephalus bergeoni* Morel & Balis, 1976. This species may belong to the *R. sanguineus* group, but at present we regard its position as equivocal.

Materials and methods

The methods employed for the maintenance of tick colonies and for cross-breeding experiments were as described for studies on the *Rhipicephalus simus* group (Pegram, 1984; Pegram *et al.*, in press).

The strain of *R. sanguineus sensu stricto* originated from an engorged female taken from a dog at Balmoral, central Zambia, in December 1980. The Egyptian strain of *R. camicasi,* originally established from an engorged female taken from a donkey, was derived from a colony maintained at the University of Cairo, Egypt. The Saudi Arabian strain of *R. camicasi* was established from partially-fed adults taken from sheep.

Two reciprocal cross-breeding experiments were undertaken using males × females: (i) *R. camicasi* (Egypt) × *R. sanguineus* (Zambia); and (ii) *R. camicasi* (Egypt) × *R. camicasi* (Saudi Arabia).

In the second experiment engorged *R. camicasi* females were weighed shortly after detachment. The numbers of eggs and larvae were determined after the completion of hatching. Regression analysis (engorged weight – number of eggs) was undertaken for females of each strain of *R. camicasi.*

Larvae, nymphae and adults from the reared strains were sent to the Rocky Mountain Laboratories, USA for scanning electron microscopy (SEM) using techniques described by Corwin *et al.* (1979). When reared specimens were not available for SEM studies, field-derived adults were used. These were examined at Brunel University, UK. Female genital aperture mounts were prepared according to the technique described by Feldman-Muhsam (1956) and modified by Pegram (1979).

Tick collections derived from field studies in Somalia, Ethiopia, the Yemen Arab Republic and Zambia (Pegram, 1976; Pegram *et al.*, 1981, 1982, 1986) formed the basis for zoogeographical studies. Additional specimens from the collections of H. Hoogstraal; the Veterinary Research Institute, Onderstepoort; the Rocky Mountain Laboratories, and J.B. Walker, plus samples submitted to one of us (RGP) by R.J. Tatchell (Tanzania and Sudan), R.M. Newson (Kenya) and R.A.I. Norval (Zimbabwe) were critically restudied. (Only specimens examined by the senior author are included as 'confirmed records').

Results and discussion

Biological studies

Cross-breeding experiments were carried out with strains of *R. camicasi* (Egypt) and *R. sanguineus* (Zambia) and with strains of *R. camicasi* (Egypt and Saudi Arabia).

R. camicasi ♂♂ × *R. sanguineus* ♀♀
Life-cycle data and results from *R. camicasi* (*R.c.*/E) and *R. sanguineus* (*R.s.*/Z) crosses are shown in Table I. Four of 10 *R. sanguineus* females mated with *R. camicasi* males engorged but only two produced a few larvae of low viability. None of the 10 females in the reciprocal cross (*R.s.* ♂♂ × *R.c.* ♀♀) engorged and no larvae were produced.

The mean engorgement period for *R. sanguineus* females was somewhat longer than that for *R. camicasi* (not significant), whereas the mean pre-eclosion period for *R. camicasi* eggs was significantly longer than that for *R. sanguineus* eggs ($P<0.01$). Adult pre-moult periods for *R. sanguineus* ranged from 10–18 days compared to 17–21 days for *R. camicasi.* Other developmental periods for the two species were similar: larval feeding 3–5 days, nymphal pre-moult 9–14 days and nymphal feeding 3–7 days.

R. camicasi (Egypt) × *R. camicasi* (Saudi Arabia)
Life-cycle and productivity data for the two strains of *R. camicasi* are shown in Table II.

Females of sibling pairs of both strains engorged slightly faster (7.9–9.6 days) than females of heterogeneous, non-sibling pairs (9.3–10.2 days). Pre-oviposition and pre-eclosion periods were generally similar in all combinations.

There were, however, significant differences in the productivity of these strains and their crosses. The Saudi Arabian strain engorged females were heavier, and produced more eggs and more larvae, than the Egyptian strain engorged females. Regression analyses of engorged weights on egg production for females of each strain are compared in Fig. 1 and Table III. The greater productivity of the Saudi Arabian strain is attributed to its recent isolation, whereas the Egyptian strain had been maintained in the laboratory for numerous generations. Similar observations have been reported for *Boophilus microplus* (Stewart *et al.*, 1982), *Amblyomma americanum* (Hunt & Drummond, 1983) and *R. appendiculatus* (Zivkovic *et al.*, 1986).

Table I. Life-cycle and reproduction data for *R. sanguineus* (Zambia) and *R. camicasi* (Egypt) and their crosses.

Strain	Number engorging	Engorgement period	Pre-oviposition period	Pre-eclosion period	Larval production	Number producing
R. sanguineus	7/7	13.0 ± 3.4 (10–19)	4.7 ± 1.5 (3–7)	23.0 ± 1.6 (21–25)	Good	5/7
R. camicasi	9/9	8.9 ± 2.3 (7–13)	4.0 ± 0.9 (3–5)	27.4 ± 1.9 (24–30)	Good	9/9
R.s. ♂ × *R.c.* ♀	0/10	–	–	–	None	0/10
R.c. ♂ × *R.s.* ♀	4/10	15.6 ± 5.6 (9–22)	4.0 (4)	39.0 (36–42)	<100	2/10

Table II. Life-cycle and reproduction data for Egyptian and Saudi Arabian strains of *R. camicasi.*

Ref. no.	Number engorging	Engorgement period	Pre-oviposition period	Incubation period	Engorged weight	Larval production	Number producing
L85-1 (Egypt)	17/20	7.9 ± 1.6 (6–11)	4.2 ± 0.5 (3–5)	30.7 ± 3.1 (27–37)	0.17 ± 0.05 (0.12–0.21)	1224 ± 1680 (25–3685)	17/20
L85-2 (Saudi Arabia)	19/20	9.6 ± 1.1 (7–11)	3.6 ± 0.9 (3–6)	30.2 ± 1.0 (29–33)	0.29 ± 0.07 (0.17–0.39)	2427 ± 1167 (328–4276)	17/20
L85-1 (E) ♂ × L85-2 (SA) ♀	20/20	10.2 ± 1.1 (8–11)	3.1 ± 0.3 (3–4)	28.2 ± 4.5 (25–43)	0.38 ± 0.06 (0.25–0.50)	1946 ± 1537 (6–3804)	20/20
L85-2 (SA) ♂ × L85-1 (E) ♀	16/20	9.3 ± 3.0 (7–17)	5.1 ± 1.0 (3–7)	31.8 ± 3.3 (28–35)	0.18 ± 0.03 (0.10–0.22)	1892 ± 1586 (12–3505)	16/20

Table III. Linear regression analysis (engorged weight – number of eggs) for Egyptian and Saudi Arabian strains of *R. camicasi.*

Strain (ref. no.)	n	$\bar{x}$	$\bar{y}$	b	r	P
R. camicasi: Egypt (L85-1)	5	159	2960	8.8	0.46	N.S.
R. camicasi: Saudi Arabia (L85-2)	7	288	4569	12.3	0.79	0.05
L85-1 (E) ♂ × L85-2 (SA) ♀	9	387	7110	19.0	0.95	0.01
L85-2 (SA) ♂ × L85-1 (E) ♀	8	182	3689	21.7	0.92	0.01

n = number of females; $\bar{x}$ = mean engorged weight of females; $\bar{y}$ = mean number of eggs produced; b = regression coefficient: covariance xy/variance x; r = correlation coefficient; P = probability of statistical significance.

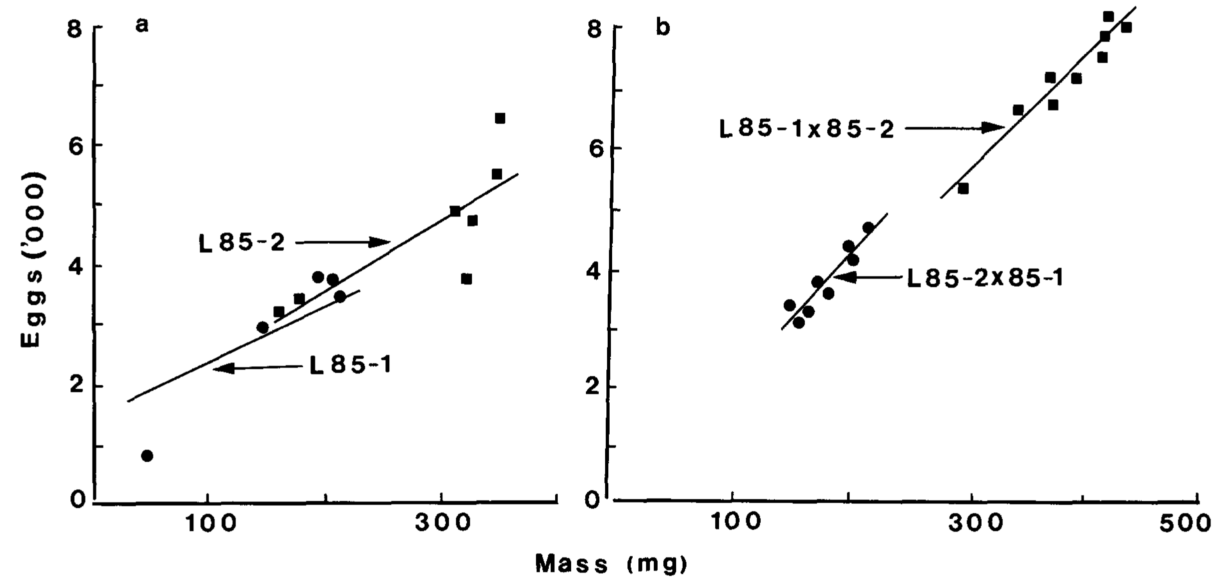


Fig. 1. Linear regression analyses of eggs numbers produced and weights of engorged females in experiments with the following strains of *Rhipicephalus camicasi:* L85-1 (Egypt); L85-2 (Saudi Arabia). (a) L85-1 and L85-2 pure strains; (b) L85-1 ♂ × L85-2 ♀ and L85-2 ♂ × L-85-1 ♀ crosses.

Diagnosis and ecology

***R. sanguineus* group adults**

Common features

Male. Coxal process not visible dorsally. Eyes flat, not furrowed; may be surrounded by a few large punctations. Lateral grooves variable but usually marked out with punctations. Marginal grooves usually deep and containing large, deep punctations. Posteromedian and paramedian grooves wide, fairly short but always distinct. Four almost regular rows of large, deep, piliferous punctations running from the level of the eyes to the posterior grooves usually distinguishable. Interstitial punctations variable in size and density. Ventrally, spiracular plates variable (but most useful diagnostic character); adanal plates usually twice as long as wide (but too variable intraspecifically to be of diagnostic value except in *R. sulcatus* and *R. bergeoni*).

Female. Scutum usually longer than wide. Scutal punctation variable as in males; overall density often appears comparatively greater. Lateral grooves usually pronounced and outlined with large punctations. Cervical areas more densely punctate but shagreening rare (except in *R. bergeoni*). Ventrally, genital aperture most valuable diagnostic feature. Spiracular plates variable (except larger in *R. guilhoni*).

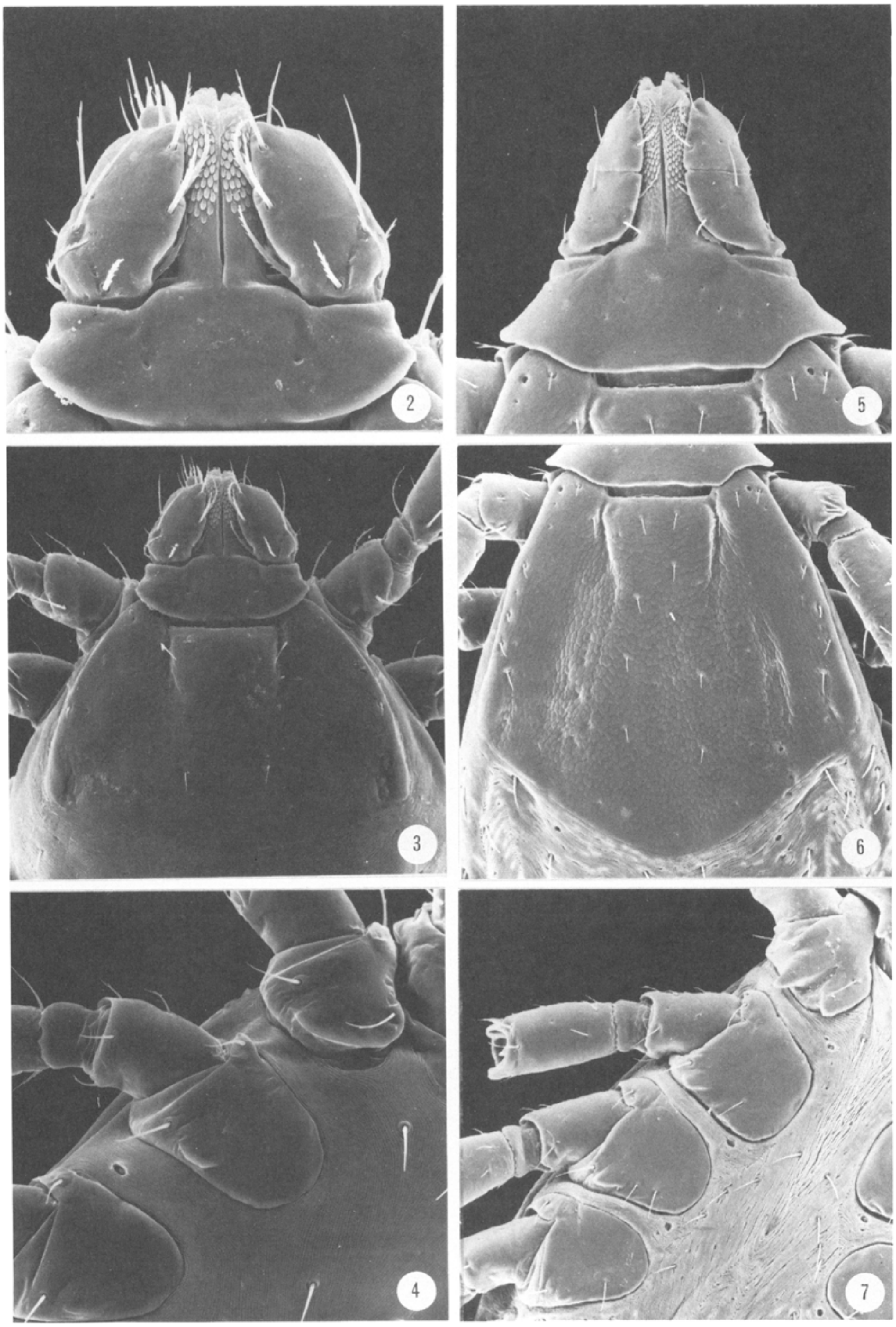
Rhipicephalus sanguineus (Latreille, 1806)

This is the type species for the genus and for the group. Opinions still differ as to whether it is of African origin (Hoogstraal, 1956) or Mediterranean origin (Morel & Vassiliades, 1963; Feldman-Muhsam, 1967).

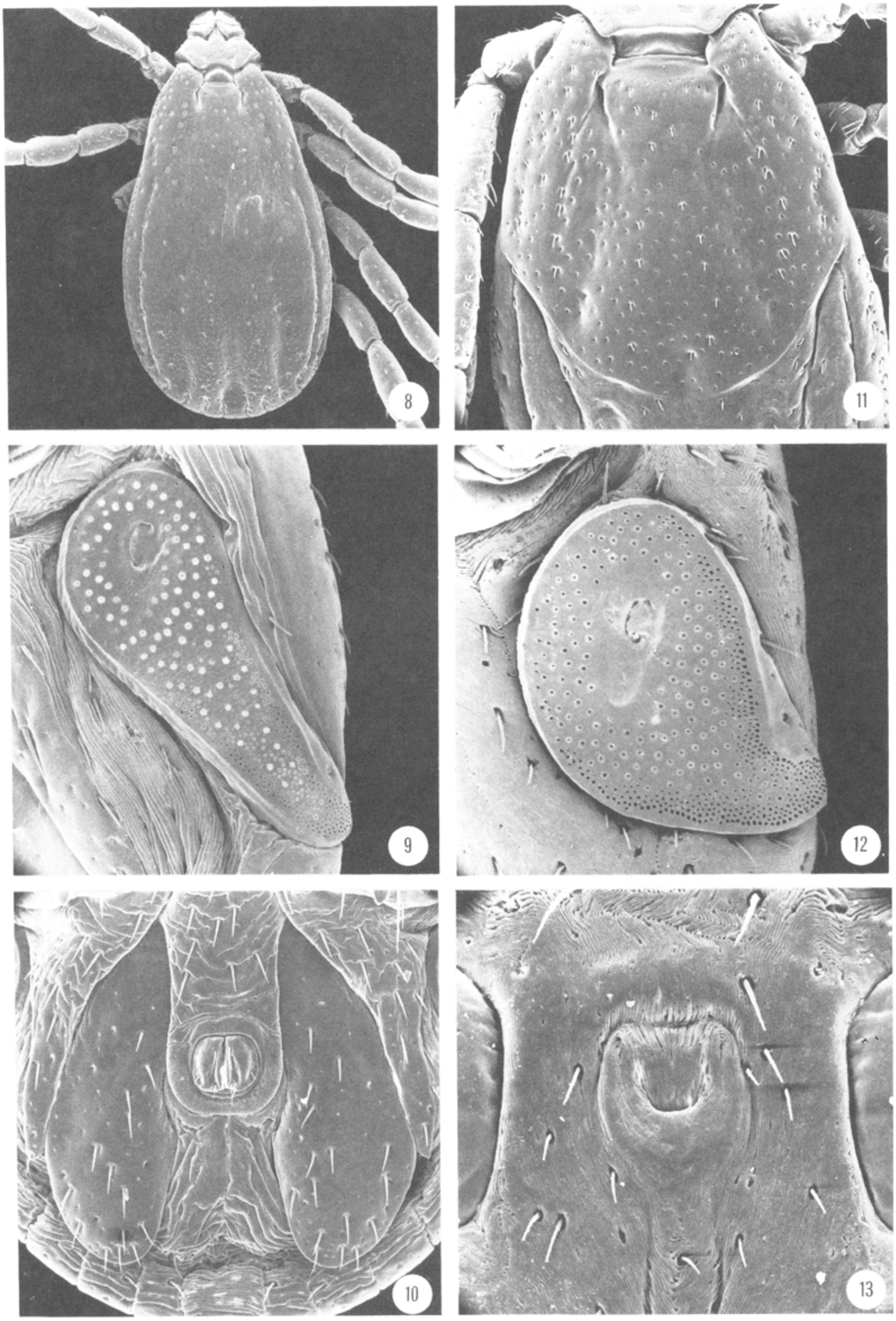
Diagnosis (L36: Figs 2–13, 38)

Larva (Figs 2–4). Lateral angles of basis capituli very short and blunt. Width of palps at their juncture with basis capituli equal to width of basis; external margin of palps slightly convex but broad at apex. Scutum only mildly convex posteriorly. Ventrally, coxa I with broad salient ridge posteriorly; coxa II with small spur; coxa III with mere indication of spur.

Nymph (Figs 5–7). Capitulum somewhat broader than long. Anterolateral margins of basis capituli and external margins of palps slightly curved. Apices of palps slightly hunched in outline with exter-



Figs 2–7. Rhipicephalus sanguineus (L36, Balmoral, Zambia; SEM). (2) Larva, capitulum, ×750; (3) Larva, capitulum and scutum, ×233; (4) Larva, coxae, ×424; (5) Nymph, capitulum, ×288; (6) Nymph, scutum, ×188; (7) Nymph, coxae, ×200.



Figs 8–13. Rhipicephalus sanguineus (L36, Balmoral, Zambia; SEM). (8) Male, dorsal, ×38; (9) Male, spiracular plate, ×212; (10) Male, adanal plates, ×112; (11) Female, scutum, ×75; (12) Female, spiracular plate, ×225; (13) Female, genital aperture, ×250.

nal margin of palpal article 3 slightly convex. Ventrally, posterointernal margin of coxa I with external spur slightly longer and narrower than internal spur; coxae II and III each with a very small spur; coxa IV with a mere indication only of a spur.

Male (Figs 8–10). Piliferous punctations distinct; interstitial punctations variable, usually light, laterally fewer and smaller. Marginal groove distinct. Spiracular plate usually with rather narrow tapering tail subequal to half the width of the adjacent festoon. Adanal plates variable, usually somewhat truncated, but occasionally rounded and resembling those of *R. sulcatus*.

Female (Figs 11–13, 38). Punctation variable but usually light. Cervical pits deep, inverted V-shape; cervical area slightly depressed; adjacent scapular area slightly raised. Genital aperture a wide, open U-shape, or rarely an open V-shape, never as deep as in *R. camicasi*. Internal flaps usually semicircular and only lightly pigmented. Spiracular plate tail usually curved and narrow.

Ecology

Over 90% of the *R. sanguineus* adults were taken from dogs (Table IV). In addition to the tabulated records, some 325 specimens were taken from houses, pastures and packing materials.

The seasonality of *R. sanguineus* infesting dogs was studied in Egypt by Amin & Madbouly (1973), who found two peak periods of female activity. The first peak in March coincided with an increase in temperature whilst the second in June coincided with an increase in relative humidity. Few adult ticks were taken between October and December. In South Africa, *R. sanguineus* on kennelled dogs was active mainly during the summer from October to April (Horak, 1982). In both the northern and southern African studies, there were two generations each summer. In cooler temperate regions there may be only one generation of adults each summer (Pomerantsev, 1950), whilst in humid tropical zones three generations may be possible (Aeschlimann, 1967).

Data for the life-cycle of *R. sanguineus* under laboratory conditions are included in the biological comparison and cross-breeding of this species with *R. camicasi* (Tables I & II).

Few examples of *R. sanguineus* were identified in collections from domesticated hosts (cattle, sheep and goats). One exception was a collection of 19 males and 24 females from cattle in Wollo Province, Ethiopia but the veterinary officer who made the collection noted '. . . most of the villages in that area had more dogs than I care to remember . . . particularly as we had to beat them off in the villages where we spent the night and the frequent reports of rabies . . .'. Thus, as Hoogstraal (1956) observed, the presence of dogs probably influences the attacks of *R. sanguineus* on cattle rather than vice versa.

Confirmed collections of *R. sanguineus* have been identified from Mauretania, Senegal, Mali, Congo, Egypt, Sudan, Ethiopia, Somalia, Uganda, Kenya, Tanzania, Angola, Zambia, Malawi, S.W. Africa/Namibia and South Africa (Fig. 14). Collections from various countries in the continents of America, Europe, Asia and Australia were examined for comparative purposes. The world wide distribution of *R. sanguineus* is generally associated with its main host, the domestic dog. Our results suggest that the previously published records, which indicate a very wide host range for this species, require critical re-evaluation.

Table IV. Host-parasite records for *R. sanguineus*.

Hosts	Number of collections	Males	Females
Domestic animals			
Cattle	3	19	27
Goat	1	3	3
Horse	1	0	1
Cat	1	0	1
Dog	57	419	392
Wild animals			
Giraffe (*Giraffa camelopardalis*)	1	4	3
Man	1	0	1

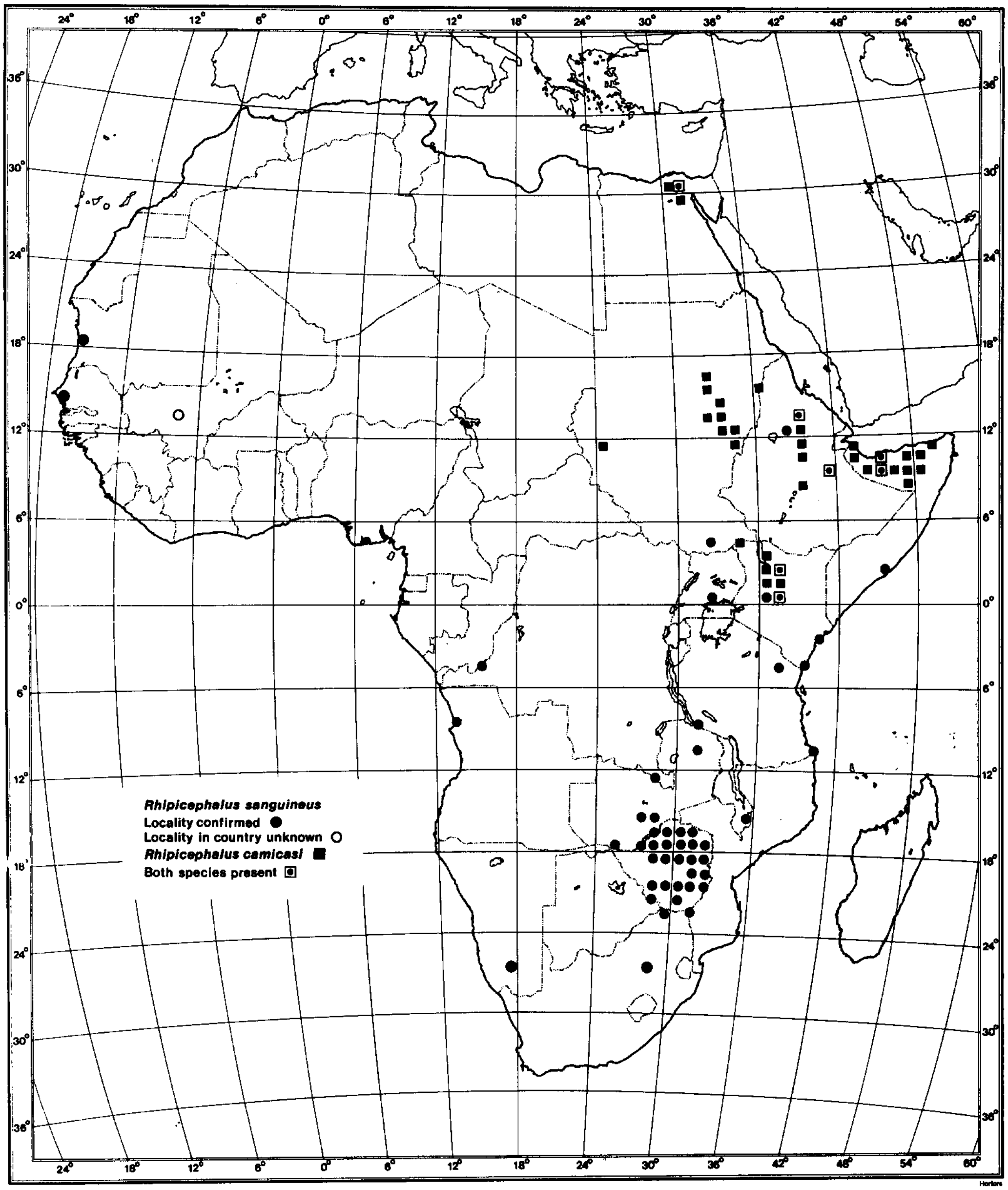
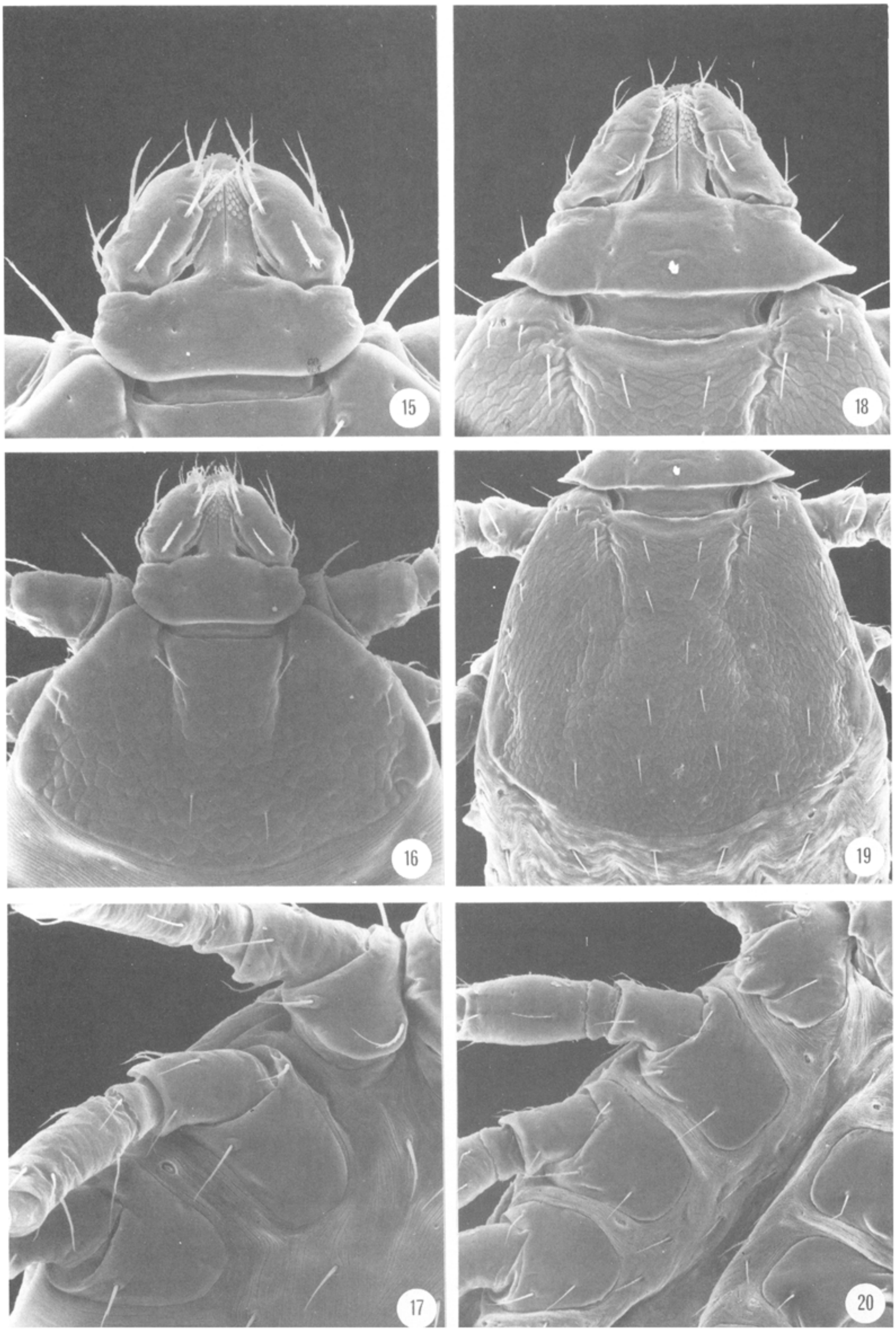


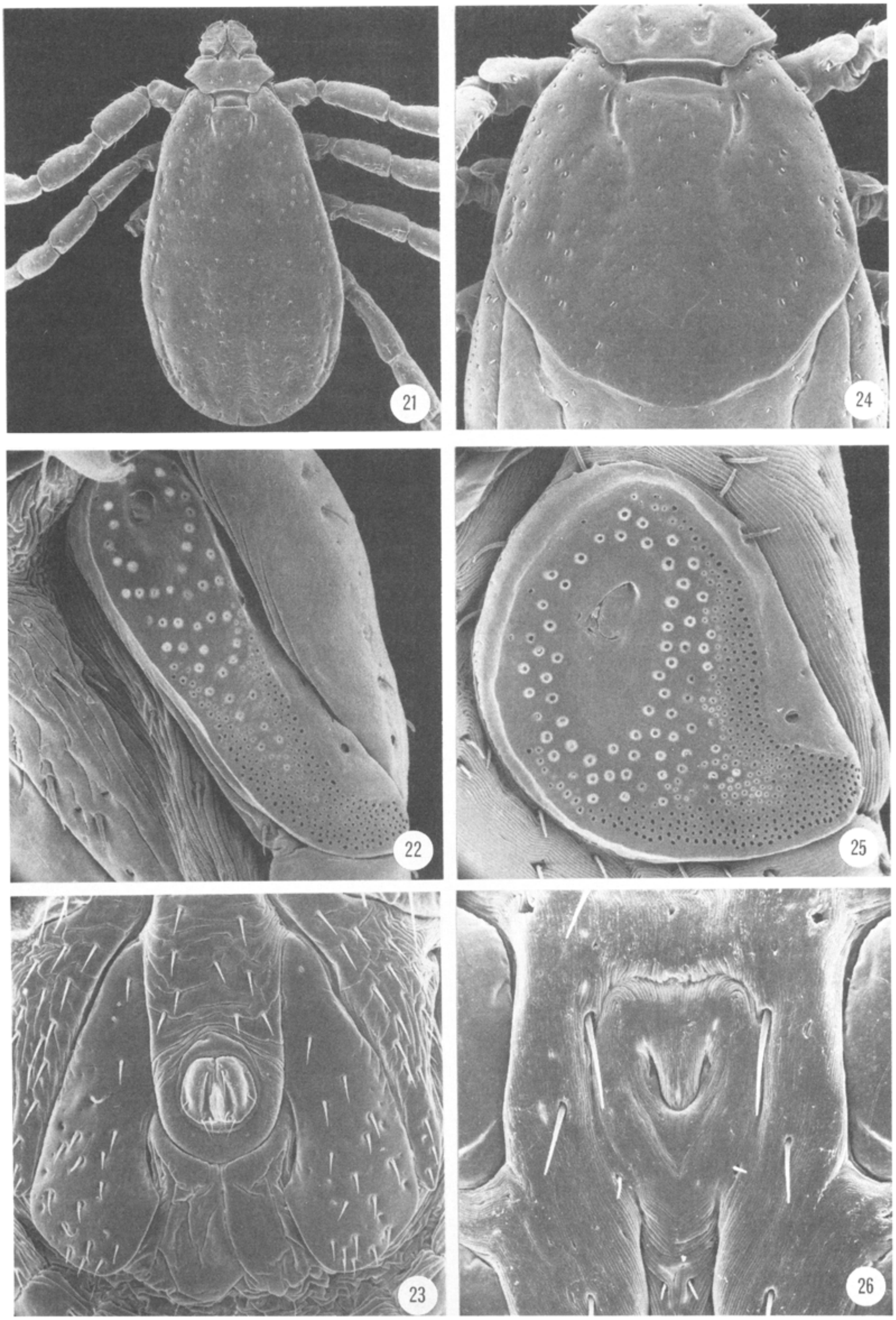
Fig. 14. Rhipicephalus sanguineus and *Rhipicephalus camicasi*. Distribution.

Rhipicephalus camicasi Morel, Mouchet & Rodhain, 1976

Diagnosis (L66: Figs 15–26, 39)
Larva (Figs 15–17). Lateral angles of basis capituli short and blunt. Width of palps at their juncture with basis capituli equal to width of basis; external margin of palps slightly convex; apex broad. Scutum smoothly bowed posteriorly. Ventrally coxa I with broad salience posteriorly; coxa II with slight indication only of spur; coxa III lacks spur.
Nymph (Figs 18–20). Capitulum over one and a half times broader than long. Anterolateral margins of basis capituli and external margins of palps slightly curved. Apices of palps slightly hunched in outline; external margin of palpal article 3 slightly convex.



Figs 15–20. Rhipicephalus camicasi (L66, Egypt; SEM). (15) Larva, capitulum, ×500; (16) Larva, capitulum and scutum, ×254; (17) Larva, coxae, ×424; (18) Nymph, capitulum, ×300; (19) Nymph, scutum, ×200; (20) Nymph, coxae, ×225.



Figs 21–26. Rhipicephalus camicasi (L66, Egypt; SEM). (21) Male, dorsal, ×38; (22) Male, spiracular plate, ×288; (23) Male, adanal plates, ×125; (24) Female scutum, ×75; (25) Female, spiracular plate, ×275; (26) Female, genital aperture, ×250.

Posterointernal margin of coxa I with a relatively long external spur and an extremely small, broad internal spur; mere indications of a spur on coxa II and III and none on IV.
Male (Figs 21–23). Piliferous punctations distinct; interstitial punctations variable, usually light, laterally fewer and smaller. Marginal groove ill-defined. Spiracular plates relatively long and narrow, equal or subequal to half width of adjacent festoon. Adanal plates variable.
Female. (Figs 24–26, 39). Punctation variable but usually light. Cervical pits comma shaped; lateral grooves indistinct or with few linear punctations; scapular area not markedly raised.

Genital aperture narrow U-shape. Internal flaps usually pigmented and parallel. Spiracular plate tail curved and narrow.

Ecology
Host records for *R. camicasi* are summarized in Table V. Additional records of this species are those of Morel (1980) from sheep, goat, hare, cheetah, fox, gerenuk, oryx, warthog and zebra, from Ethiopia and Djibouti. This species is the commonest rhipicephaline tick on livestock in the Yemen Arab Republic and occurs on cattle, camels, sheep, goats and donkeys (Pegram & Zivkovic, unpublished data).

R. camicasi occurs mainly in arid and semi-arid habitats receiving less than 250 mm annual rainfall.

Table V. Host-parasite records for *R. camicasi.*

Hosts	Number of collections	Males	Females
Domestic animals			
Cattle	10	58	51
Camels	6	62	64
Sheep	6	20	42
Goats	2	28	22
Sheep and goats	14	45	61
Mixed domestic animals	6	170	180
Wild animals			
Antbear (*Orycteropus afer*)	1	0	4
Zebra (*Equus* sp.)	1	0	1

It extends from Egypt southward through Sudan, Ethiopia and northern Kenya and eastward into the Somali Republic and Djibouti (Fig. 14). Its western limits are not as yet clearly defined. In middle eastern countries, the presence of *R. camicasi* has been confirmed in Saudi Arabia, Lebanon and Jordan (Clifford & Pegram, unpublished data).

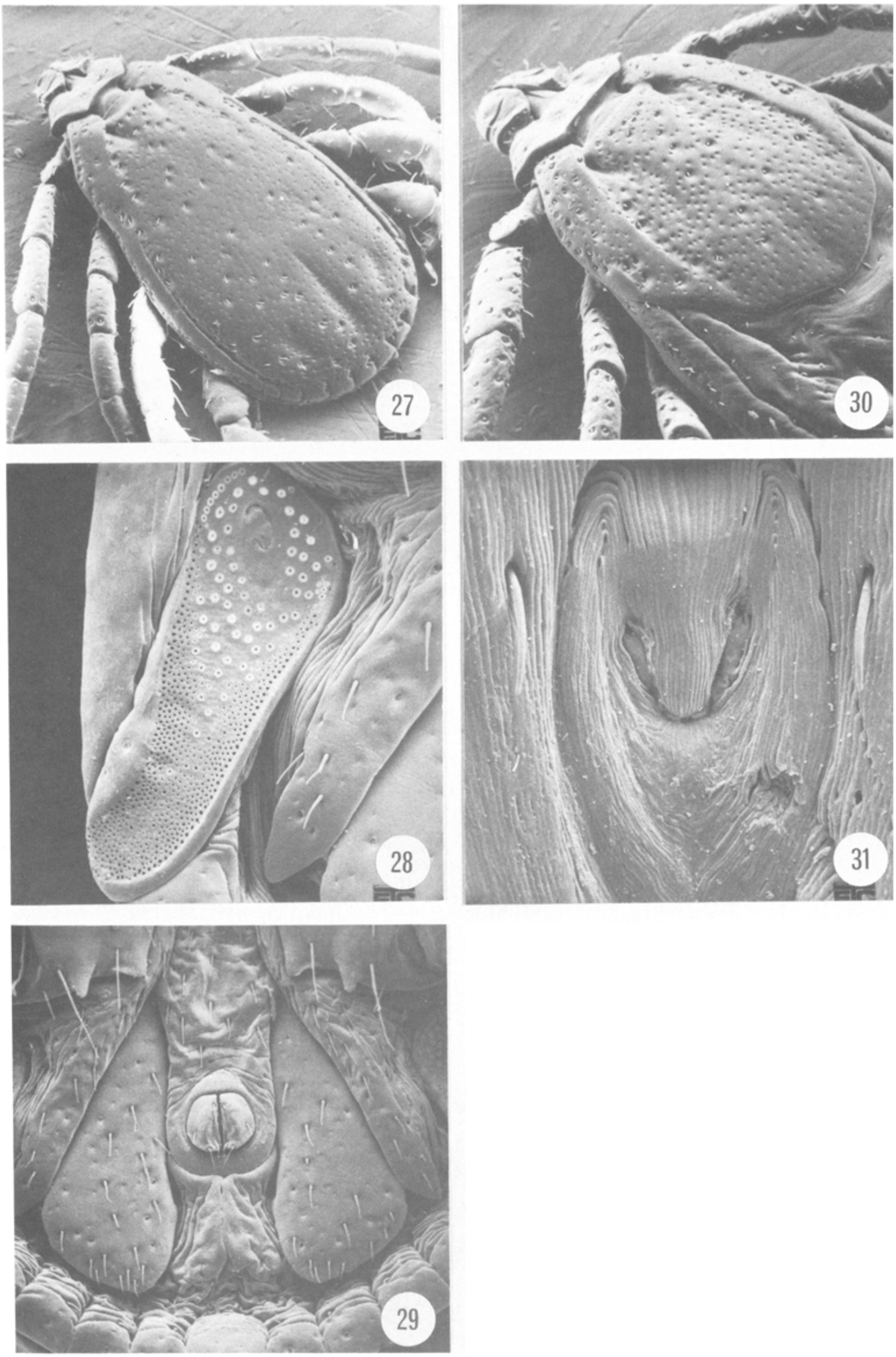
In Ethiopia and Somalia, *R. camicasi* appears to be most active in dry season periods.

Rhipicephalus guilhoni Morel & Vassiliades, 1963

Diagnosis (Figs 27–31, 40)
Male (Figs 27–29). Scutum as in other *R. sanguineus* group species. Interstitial punctation variable, usually moderate to dense. Spiracular plates large and broad with width at tail end equal to 1 festoon. Adanal plates variable but as in other members of group.
Female (Figs 30–31, 40). Scutum variable as in males but usually elongate. The unmounted genital aperture V- or U-shape with distinctive lateral hyaline margins. The mounted genital aperture with marked convexity of flaps (cf. *R. sanguineus*) but with distinctive hyaline margins. Spiracular plates distinctly large with wide tail end acutely angled.

The larva and nymph of *R. guilhoni* were described by Morel & Vassiliades (1963), but Filippova (1981) believed that there is some confusion in their descriptions between this species and *R. turanicus.*

Ecology
The few confirmed specimens of *R. guilhoni* examined for this study were taken from camels (1♂, 2♀♀), sheep (23♂♂, 30♀♀), *Canis* sp. (4♂♂, 4♀♀) and reared series (3♂♂, 4♀♀). They were collected in Senegal, Egypt, Sudan and Ethiopia (Fig. 32). Morel & Vassiliades (1963) include Cameroon, Chad, Mali, Mauritania, Nigeria, Senegal and Burkina Faso (formerly Upper Volta) in the range of this species, generally in habitats receiving 250–750 mm annual rainfall. Our recent records indicate that *R. guilhoni* also extends into more



Figs 27–31. Rhipicephalus guilhoni (Senegal; SEM). (27) Male, dorsal, ×32; (28) Male, spiracular plate, ×160; (29) Male, adanal plates, ×80; (30) Female, scutum, ×40; (31) Female, genital aperture, ×400.

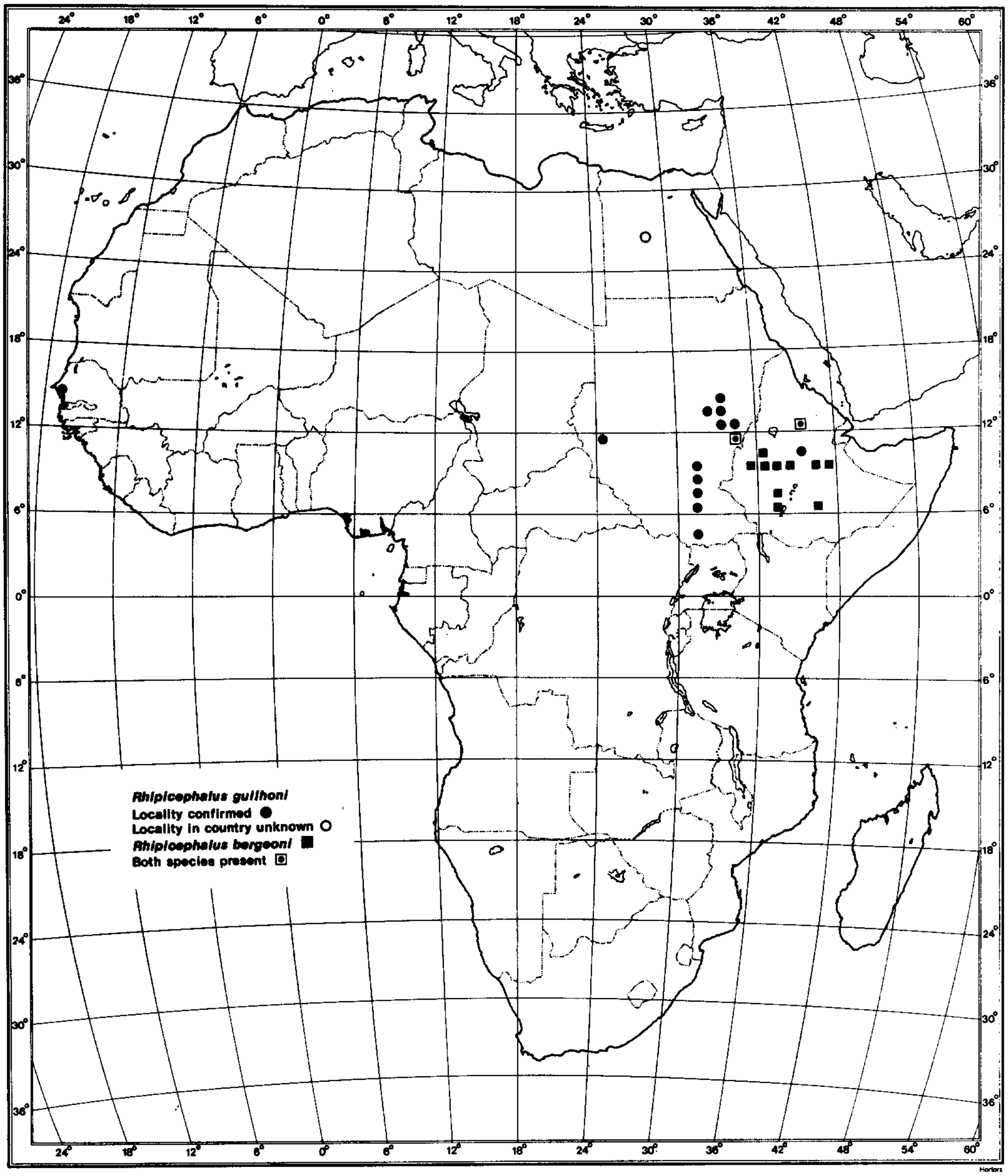


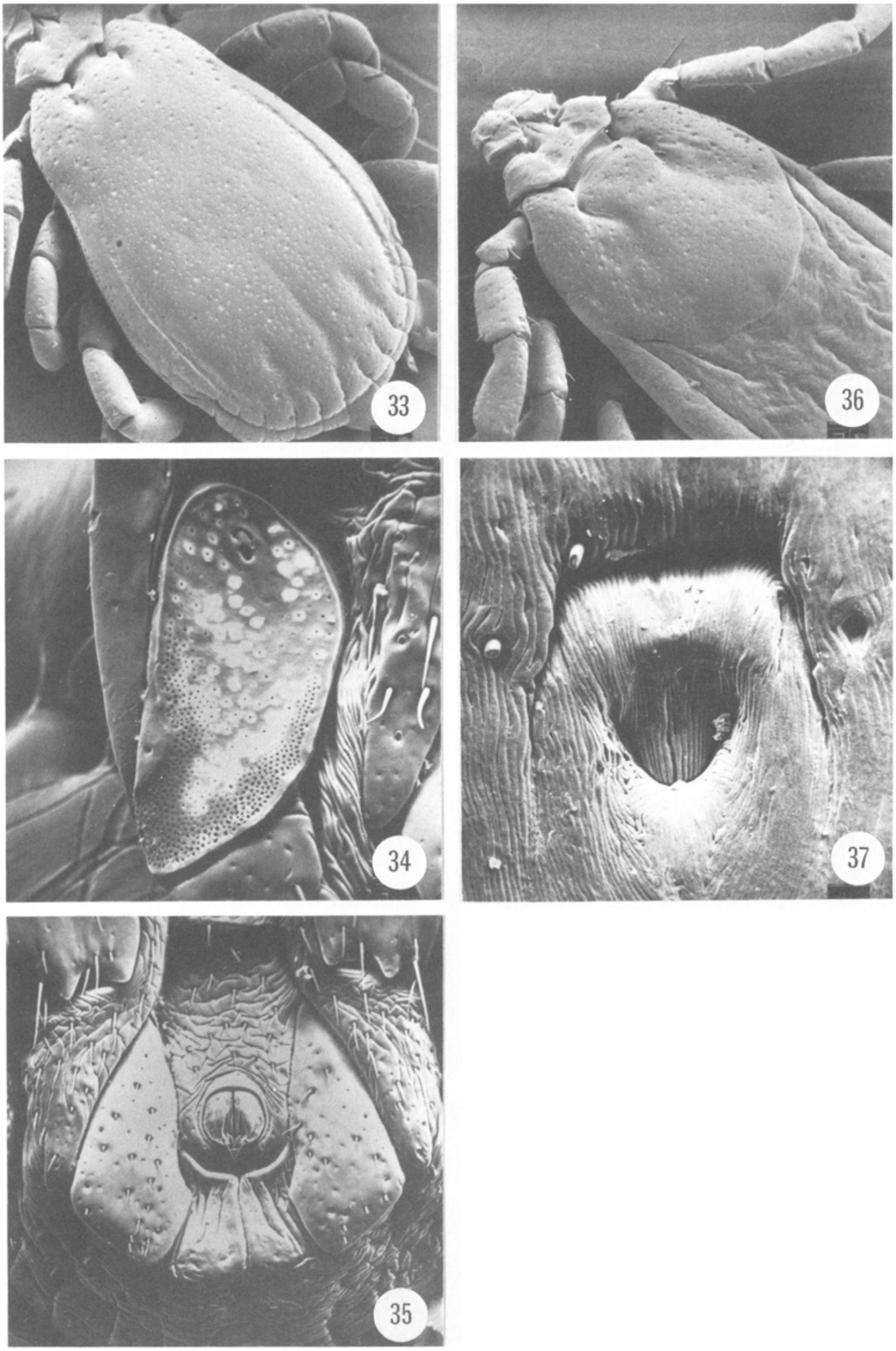
Fig. 32. Rhipicephalus guilhoni and *Rhipicephalus bergeoni.* Distribution.

arid habitats in the northern parts of Sudan and Ethiopia and in Egypt.

Rhipicephalus moucheti Morel, 1965

We have no material of this species for comparative studies but the original description and illustrations, based on two male ticks, by Morel (1965) suggest that this West African species should be included in the *R. sanguineus* group.

Morel's description and figures, and the redescription by Saratsiotis (1981), indicate that this is a relatively heavily punctate tick. (On his figure of the male dorsum Saratsiotis actually shows an extremely light punctation pattern but this does not agree with his statement that 'dans l'ensemble la ponctuation est dense, régulièrement distribuée



Figs 33–37. Rhipicephalus bergeoni (Ethiopia; SEM). (33) Male, dorsal, ×32; (34) Male, spiracular plate, ×160; (35) Male, adanal plates, ×80; (36) Female, scutum, ×32; (37) Female, genital aperture, ×400.

...'). An important character, unique for a species in the *R. sanguineus* group, is that the adanal plates are sickle-shaped. It was primarily this feature that prompted Morel to describe *R. moucheti* as a new species.

In his description of the *R. moucheti* female Saratsiotis observes: 'Scutum à grosses ponctuations, uniformes, denses, régulièrement distribuées, piliféres, presque indiscernables des interstitielles'. His illustration conforms with this description.

Saratsiotis also describes the larva and nymph of this species and gives details of its life-cycle in the laboratory.

Morel's holotype was collected from a Patas monkey (*Erythrocebus patas*) and his paratype from a bovine. Saratsiotis lists 10 collections from dogs. It has been found in Cameroon, Benin (formerly Dahomey) and Guinea.

Rhipicephalus bergeoni Morel & Balis, 1976

This species was previously confused with *Rhipicephalus appendiculatus* Neumann, 1901 and occasionally with other members of the *R. sanguineus* group (Morel & Balis, 1976; C.M. Clifford & M.N. Kaiser, unpublished data). Its position in the *R. sanguineus* group remains somewhat equivocal.

Its life-cycle has not been studied and the larva and nymph are unknown. Descriptions of the male and female are based on field material only.

Diagnosis (Figs 33–35)
Male (Figs 33–37). Fairly large species; some specimens up to 4.5 mm long. Piliferous punctations distinct; interstitials variable in size and density; usually moderately dense but fewer punctations laterally (cf. *R. appendiculatus*). Positions of lateral grooves merely indicated by a few punctations; cervical fields shallow with very light punctations; these fields and posterior grooves usually shagreened. Spiracular plates broad and short. Adanal plates broad with posterointernal and posteroexternal margins angular. In most specimens the posterior points of these plates are divergent.
Female (Figs 36–37, 41). Scutal length equal to or greater than the width. Grooves and punctations similar to those of males. Note that general impression is not typical of *R. sanguineus* group. Unmounted genital aperture a short open V- or U-shape. Mounted genital aperture similar to *R. turanicus* but often somewhat larger. Opening is wide and overlaps the flaps.

Ecology
Most confirmed records of *R. bergeoni* are from cattle (Table VI) in the wetter highlands and subhighlands of Ethiopia (Fig. 32). One large collection of ticks from cattle at Damazein in southeastern Sudan also contains a high proportion of *R. bergeoni* adults. Morel's 1980 records are mainly from cattle. Its predilection site is the ears: it comprised 94% of one collection from this site.

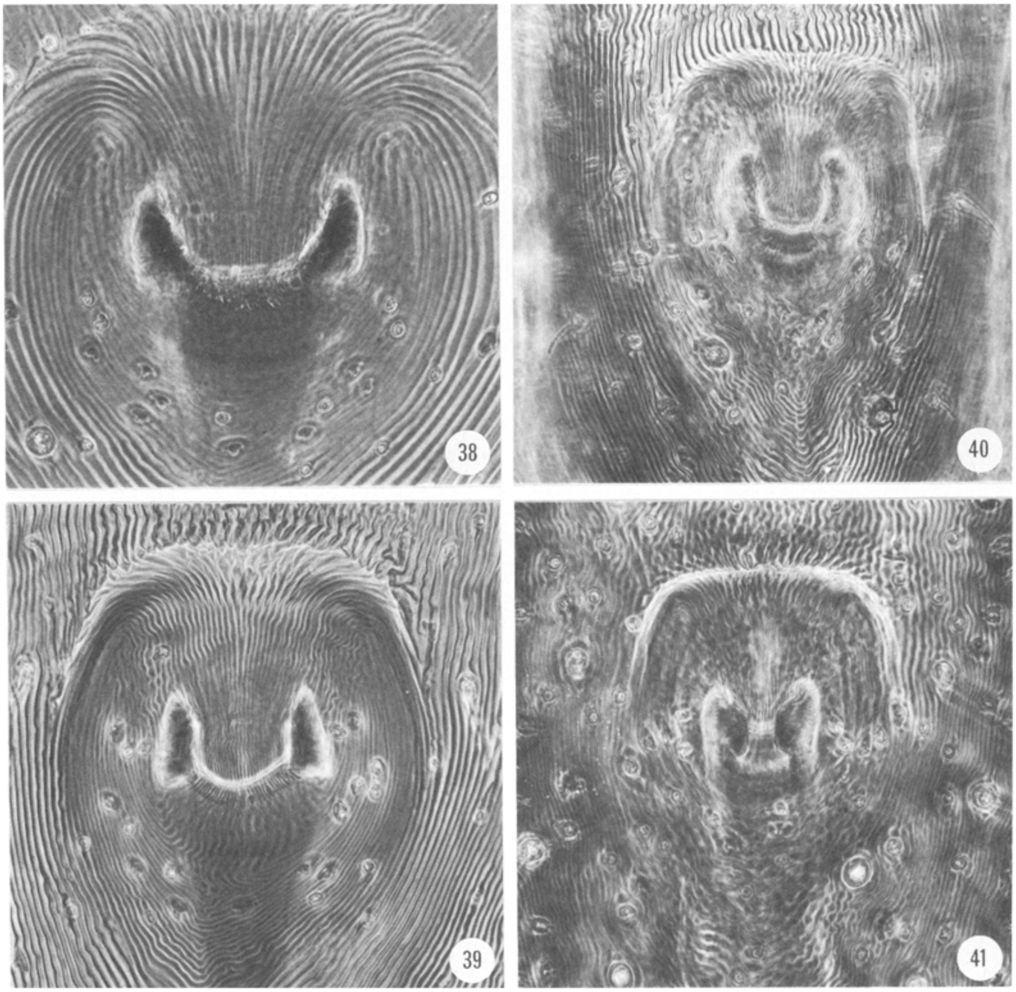
R. bergeoni is often associated with *A. variegatum*. In one series of whole body collections 37% were *R. bergeoni*, 35% *A. variegatum* and the remaining 28% other *Rhipicephalus* and *Hyalomma* spp.

Twenty-six of the 27 Ethiopian collections were taken between June and September, coinciding with the rainy season in areas receiving more than 1,000 mm annual rainfall.

Morel (1980) lists as *R. bergeoni* 14 ♂♂, 7 ♀♀ from *Hyaena hyaena* that were originally identified as *R. supertritus* by Bergeon & Balis (1974). These ticks are presently in the Hoogstraal collection and one of us (RGP) has now confirmed their original identification as *R. supertritus*.

Table VI. Host-parasite records for *R. bergeoni*.

Hosts	Number of collections	Males	Females
Domestic animals			
Cattle	27	446	370
Sheep	1	5	3
Wild animals			
Bushbuck			
(*Tragelaphus scriptus*)	1	4	4



Figs 38–41. Female genital apertures (mounted). (38) *Rhipicephalus sanguineus;* (39) *Rhipicephalus camicasi;* (40) *Rhipicephalus guilhoni;* (41) *Rhipicephalus bergeoni.*

Conclusions

In our comparative studies on the morphology, biology and ecology of members of the *R. sanguineus* group we have confirmed the presence of five species in the Afrotropical region: *R. sanguineus sensu stricto, R. sulcatus, R. turanicus, R. camicasi* and *R. guilhoni.* In addition the studies of Morel (1965) and Saratsiotis (1981) show the probable validity of *R. moucheti* as a member of this group. According to Saratsiotis the immature stages of this species conform to the group's usual pattern. In our opinion, though, the male adanal plates, which are sickleshaped, are not typical.

The position of *R. bergeoni* remains uncertain. Its immature stages are unknown but on the basis of the morphology and ecology of its adults alone its inclusion in the *R. sanguineus* group is questionable.

Further comparative studies on the genus *Rhipicephalus* are urgently required because criteria needed for defining phylogenetic and phenetic groupings are inadequate. Analyses of the host-parasite relationships of the immature stages within *R. sanguineus* group species will undoubtedly provide further data (Walker, 1961). Host relations of the adults are so diverse as to be of little value. *R. sanguineus sensu stricto* appears to be almost a specific parasite of the domestic dog, and could be included in the 'strict-total' category of Hoogstraal & Aeschlimann (1982), whereas at the other extreme *Rhipicephalus turanicus* may be categorised as 'non-particular' as it parasitizes a wide range of reptiles, birds and mammals.

The zoogeographical distribution of species in this group also requires further investigation using revised differential diagnostic criteria. We have found that *R. sanguineus sensu stricto, R. sulcatus* and *R. turanicus* are ubiquitous in those parts of the Afrotropical region in which both the available hosts and climate are suitable. The latter two species are sympatric over much of their wide range in this region. In much of western and eastern Africa *R. guilhoni* is also common (Morel & Vassiliades, 1963). *R. camicasi,* though, occurs only in the arid and semi-arid lowlands of eastern Africa. In the latter area, *R. bergeoni* is restricted to more humid highlands and subhighlands. The rare species *R. moucheti* is known only from restricted localities in western Africa.

The vector capacities of all species in the *R. sanguineus* group require re-evaluation. Much of the earlier work on disease relations cited by Hoogstraal (1956) and Morel (1980), and reported by Hafez *et al.* (1981), is equivocal owing to uncertainty about the identity of the tick species. Undoubtedly, both *R. sanguineus* and *R. turanicus* may be vectors for *Babesia canis* (Achuthan *et al.*, 1980; Tyler & Pegram, unpublished data).

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