

FIELDIANA • ZOOLOGY

Published by

CHICAGO NATURAL HISTORY MUSEUM

Volume 39

APRIL 22, 1959

No. 28

TICKS (IXODOIDEA) OF ARABIA

With Special Reference to the Yemen¹

HARRY HOOGSTRAAL
AND
MAKRAM N. KAISER

DEPARTMENT OF MEDICAL ZOOLOGY
UNITED STATES NAVAL MEDICAL RESEARCH UNIT No. 3

INTRODUCTION

Late in 1950, His Majesty Imam Ahmed Bin Yahya Hamid Al-Din, King of the Yemen, invited the Director of the United States Naval Medical Research Unit, Cairo, to send a group of experts to make a brief medical survey of the Yemen for His Majesty's guidance in future administration of disease control. The Yemen collections reported herein, totaling 9178 specimens, were obtained by the senior author during this study, in January and February of 1951.

For an excellent account of the Yemen, with emphasis on its biological features, the reader is referred to Scott (1942).

A popular account of this work has already been presented (Hoogstraal, 1952) as well as a geomedical survey (Mount, 1953; quoted by Girolami, 1952). Specialized studies resulting from this mission have since been published as follows: intestinal protozoa and helminth parasites (Kuntz, Malakatis, Lawless, and Strome, 1953), serological and bacteriological survey (Mount and Baranski, 1953), epidemiology of schistosomiasis (Kuntz, 1952), amphibians and reptiles (Schmidt, 1953), mammals and ectoparasites (Sanborn and Hoogstraal, 1953), *Phlebotomus* (Theodor, 1953), Nycteribiidae (Theodor and Moscona, 1954), mosquitoes (Knight, 1953a,b; Mattingly and Knight, 1956), mites (Radford, 1954), a human intestinal fluke

¹ The opinions and assertions contained herein are the private ones of the authors and are not to be construed as official or as reflecting the views of the Navy Department or the naval service at large.

Research Report NM 005 050.39.58.

Library of Congress Catalog Card Number: 59-10695

No. 871

297

THE LIBRARY OF THE

MAY 22 1959

NATURAL
HISTORY SURVEY
LIBRARY

UNIVERSITY OF ILLINOIS

7 1959

in a bat (Macy, 1953), a new species of tick (Arthur, 1955), and Streblidae (Jobling, 1958).

The only previously published data on ticks of the Yemen are a brief report of mostly questionable records of four species by Franchini (1930), which were repeated by Grimaldi (1934), and Arthur's (1955) description of a new species collected during the present mission.

The delay in completing this report has been necessitated by uncertainties over the identity of *Hyalomma* species. Of the 9178 specimens collected, 7539 (more than 80 per cent) were of this genus. *Hyalomma* species are undoubtedly the most important ticks from the medical and veterinary standpoint in Arabia, North Africa, and the Near and Middle East. After considerable field and laboratory study devoted to this genus, in which the junior author has played an active and material role, it is felt that specific concepts are now stable enough so that *Hyalomma* names utilized herein refer to recognizable specific entities. An equally perplexing problem contributing to this long delay has been the status of Yemeni populations of *Haemaphysalis sulcata* (Hoogstraal, in press).

Full data and illustrations for most species reported herein have been presented (Hoogstraal, 1956). Species not mentioned in this monograph are, in most instances, illustrated and annotated in the present report. The date of capture of Yemen specimens is not specified, since all were taken in January and February of 1951. All specimens from wild animals were either taken from a single host or the number of hosts is noted in parentheses following the host name.

Available data concerning species of ticks in other areas of Arabia are provided in the last section of this report.

TICKS OF THE YEMEN

Family ARGASIDAE

Argas persicus (Oken, 1818). The Poultry Argas or Fowl Tick.

Hodeida, sea level: numerous nymphs and adults, in chicken house.

The fowl tick was sought only at Hodeida. It probably also occurs in the Yemen highlands.

Ornithodoros savignyi (Audouin, 1827). The Eyed Tampan.

Near Hodeida, sea level: numerous nymphs and adults, under tree beside trail.

Near Ta'izz, 4000 ft. alt.: numerous nymphs and adults, under tree beside trail.

190.5
I
pl. 39
no. 28
sp. 3

In the Yemen, eyed tymphans are considerably more common in camel yards and under trees where camels rest than these two records indicate. People greatly fear their bites and infested sites are famous for miles around.

Ornithodoros sp. Figure 49.

Near Ta'izz, 3700 ft. alt.: 1 larva, off *Mus musculus bactrianus* (feral).

This large larva, which conforms to none other known, probably represents a unique species that should not be difficult to discover in rodent burrows in the Ta'izz area.

Diagnosis.—Larva (engorged) measures 2.20 mm. long and 1.37 mm. wide. Lateral margins parallel, posterior margin bluntly rounded, anterior margin slightly more acutely rounded. Lateral hairs numbering approximately 36, equidistantly spaced; those posterior to the legs longer than those anterior to coxa III. Dorsal surface finely shagreened; a subcircular squamous area present on anterior half. Body grooves obscure. Mouth parts concealed from dorsal view, arising from basis capituli situated midway between coxa I and anterior body margin; hypostome elongate (not dissected), 2/2 dentition, no apparent corona, apex rounded; palpi moderately narrow,

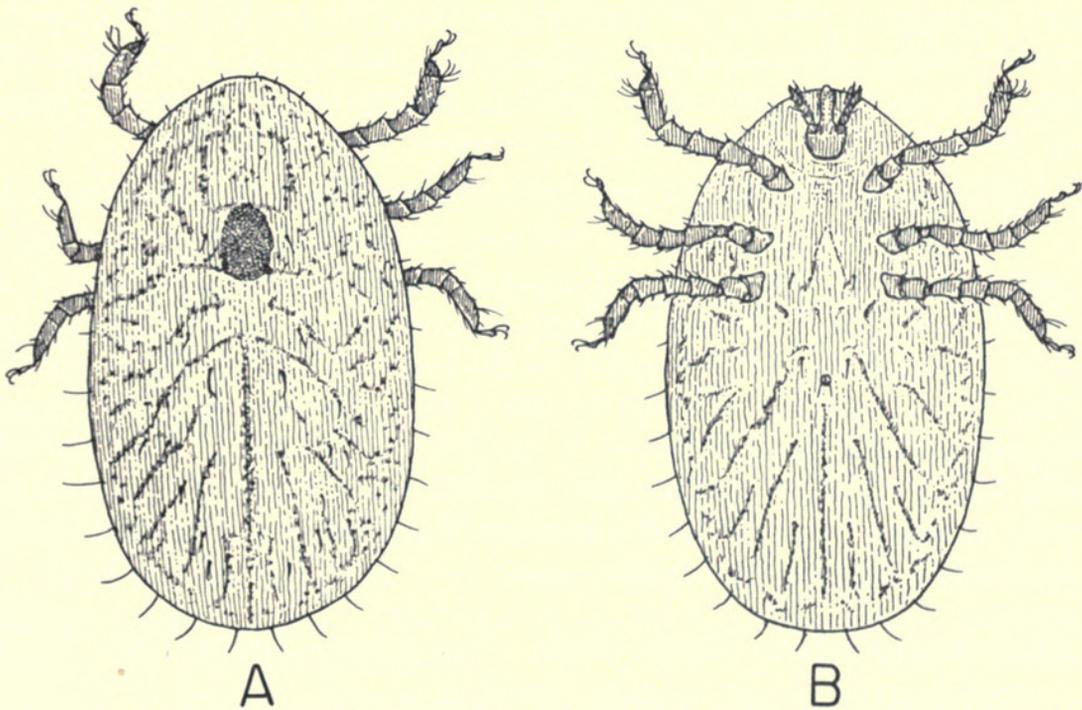


FIG. 49. *Ornithodoros* sp. (engorged larva): A, dorsal view; B, ventral view. Ta'izz area.

reaching apex of hypostome. Legs moderately wide and long, with small, indistinct coxae and acutely tapered tarsi.

Family IXODIDAE

Amblyomma gemma Dönitz, 1909. The East African Highland Bont Tick.

Ta'izz, 4100 ft. alt.: 1 male, off cattle.

The single male from the Yemen corresponds to the description of this species presented by Robinson (1926) and Theiler, Walker, and Wiley (1956). However, as Dönitz (1909) has already stated, with his typical perspicacity, *A. gemma* may prove to be a variety of *A. eburneum* Gerstaecker, 1873. The strong suspicion that Dönitz may be right has been aroused from evidence obtained during the 1956 Scientific Working Party on Ectoparasites and Arthropod-borne Diseases in East Africa. This subject will be thoroughly reviewed in a later work (Hoogstraal, in preparation), and, therefore, will not be further discussed here on the basis of a single specimen.

Amblyomma variegatum (Fabricius, 1794). The Tropical Bont Tick.

Ta'izz area, 4100 ft. alt.: 3 larvae, 11 nymphs, off *Lepus a. arabicus*; 4 nymphs, 1 male, off *Gazella g. arabica*; 2 nymphs, off *Vulpes v. arabica* (Jebel Zarba, 7000 ft.); 84 nymphs, 148 males, 46 females, off domestic cattle; 22 males, 3 females, off domestic camels; 1 male, off domestic dog; 1 male, off human being (engorging on).

Ma'bar, 7400 ft. alt.: 2 males, 2 females, off domestic cattle.

Half of the specimens from domestic camels at Ta'izz are strongly suggestive of *A. pomposum* (Hoogstraal, 1956, p. 245). Franchini's (1930) record of *A. variegatum* from Hodeida most probably refers to ticks on highland cattle brought to the coast for slaughter or export. This tick's breeding grounds in the Yemen appear to be confined largely to the irrigated valleys of the middle highlands. The finding of a large number of nymphs and females on Ta'izz cattle in January may indicate that this is the season during which nymphs molt to adults and females feed in this area.

Aponomma latum (Koch, 1844). The African Snake Tick.

Ta'izz, 4100 ft. alt.: 1 male, off *Psammophis schokari*.

Three other specimens of this snake, from Hodeida and Wadi el-Ghail, were uninfested, as were 10 specimens of other kinds of snakes

from various localities in the Yemen (see Schmidt, 1953, for reptile data).

It is of some interest that while the single *Aponomma* tick known from a snake in southwestern Arabia is a species endemic in the Ethiopian Faunal Region, the several specimens of this genus from *Varanus* lizards in this area represent an Oriental species (see p. 318).

Boophilus annulatus (Say, 1821). The Texas-Fever Tick.

Ta'izz area, 4100 ft. alt.: 29 males, 804 females, off domestic cattle; 49 females, off domestic camels; 2 males, off domestic dogs; 3 females, off domestic goats; 2 males, off domestic sheep; 2 males, in house; 1 female, under rock.

Ma'bar, 7400 ft. alt.: 1 female, off domestic cattle.

No specimens of *B. decoloratus*, the species common in the Ethiopian Faunal Region, were found in the Yemen. Had we realized this when in the field, we should have made greater effort to secure material from a wider range of hosts in more localities, in anticipation of recognizing the presence of small, scattered populations of this African tick.

Haemaphysalis leachii leachii (Audouin, 1827). The Yellow Dog-Tick.

Ta'izz area (Jebel Zarba, 7000 ft. alt.): 2 males, off *Vulpes v. arabica* (see discussion below).

Haemaphysalis leachii muhsami Santos Dias, 1954. The Yellow Small-Carnivore Tick.

Ta'izz area (Jebel Zarba, 7000 ft. alt.): 3 males, 1 female, off *Vulpes v. arabica* (see discussion below).

Haemaphysalis leachii subsp.

Ta'izz area: 4 larvae, 9 nymphs, off *Acomys dimidiatus homericus* (9); 1 nymph, off *Arvicanthus niloticus naso* (6).

The immature stages of *H. leachii* cannot be identified with certainty to subspecies. The finding of both subspecies on a single host is not uncommon in Africa.

Haemaphysalis sulcata Canestrini and Fanzago, 1878. The Middle East Lizard Haemaphysalid. Figure 50.

Ta'izz area, 4100 ft. alt.: 2 larvae, 19 nymphs (2 females reared from nymphs), off *Agama adramitana*; 2 larvae, off *Acanthodactylus boskianus asper*; 2 males, off domestic cow.

Ma'bar, 7400 ft. alt.: 2 larvae, 14 nymphs, off *Eremias g. guttulata* (2); 4 males, off domestic cattle.

This species, including populations from the Yemen, has been reviewed by Hoogstraal (in press). It appears to form a widely ranging cline, Yemeni populations of which show an abrupt geographical gradient indicated chiefly by the smooth male scutum with scattered large punctures and almost complete obsolescence of the dense small punctures that are characteristic of typical populations of this species in most other geographic areas. Populations in the mountains of Sinai closely conform to those from the mountains of the Yemen, and factors associated with altitude are suggested as influencing morphological gradients in these areas.

Hyalomma anatolicum anatolicum Koch, 1844 (*sensu* Pomerantzev). The Small Hyalomma.

Hodeida area, sea level to 100 ft. alt.: 236 males, 306 females, off domestic camels; 24 males, 32 females, off domestic cattle (for slaughter); 11 males, off domestic sheep; 1 female, off *Lepus arabis* subsp.

Ta'izz area, 4100 ft. alt.: 956 males, 774 females, off domestic camels; 267 males, 222 females, off domestic cattle; 142 males, 54 females, off domestic goats; 7 males, 10 females, off domestic dogs.

Ma'bar area, 7400 ft. alt.: 11 males, 10 females, off domestic goats.

San'a area, 7100 ft. alt.: 3 males, 6 females, off domestic camels; 5 males, 7 females, off domestic goats.

The large numbers of engorging females in these collections would indicate that January and February are within the breeding season of *H. a. anatolicum* at various altitudes in the Yemen. For a review of the *anatolicum* complex, see Hoogstraal and Kaiser (in press). The subspecies *anatolicum* is the widely ranging, ubiquitous form previously considered as "*H. excavatum*" (*sensu* Delpy) by non-Soviet workers.

Hyalomma anatolicum excavatum Koch, 1844 (*sensu* Pomerantzev). The Large Anatolian Hyalomma.

Ta'izz area: 9 males, 4 females, off domestic cattle; 10 males, 1 female, off domestic camels.

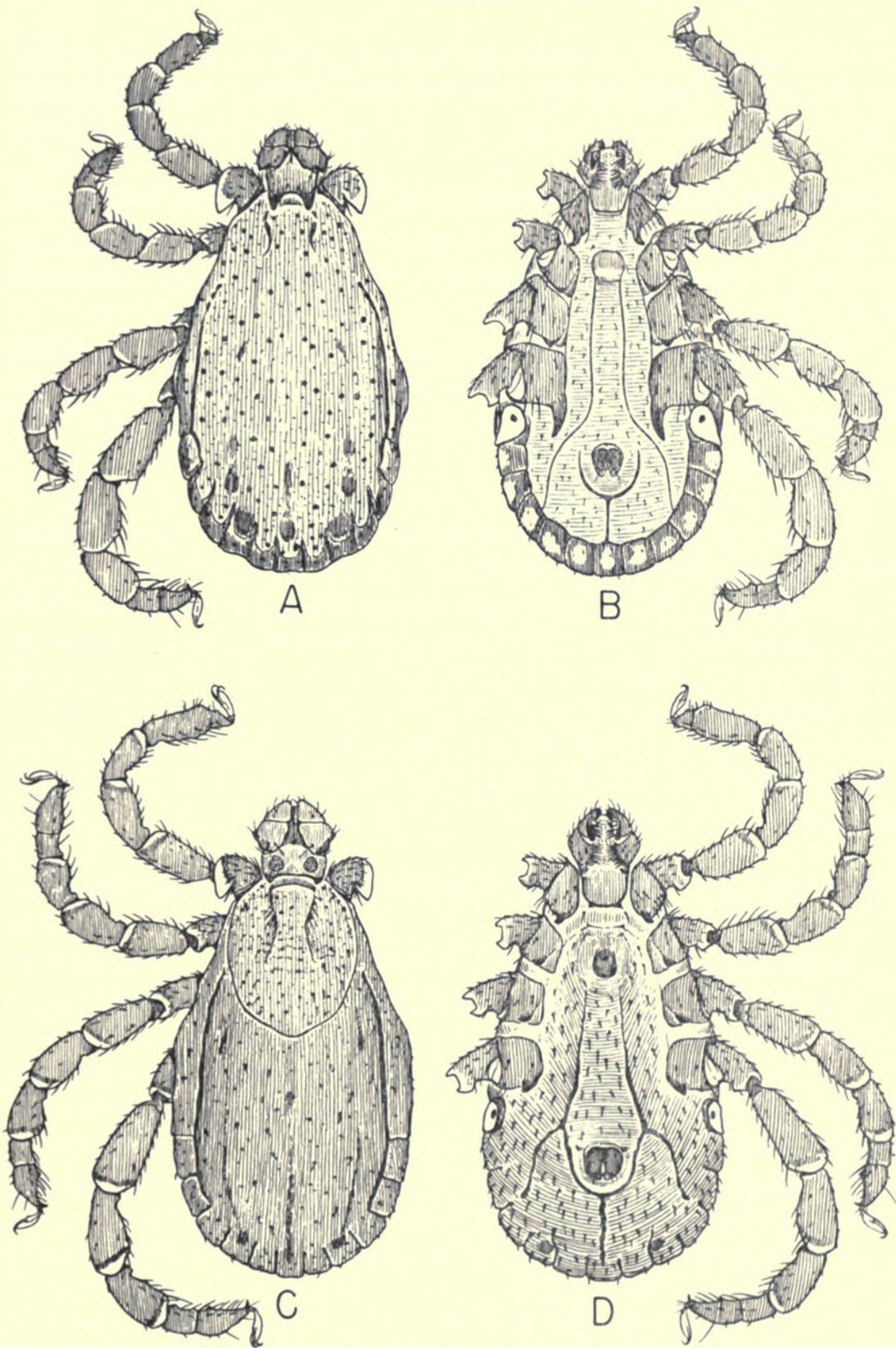


FIG. 50. *Haemaphysalis sulcata* Canestrini and Fanzango. A, B, male, dorsal and ventral views; Ta'izz, from cow. C, D, female, dorsal and ventral views; reared from nymph from *Agama adramitana*.

This tick ranges through southeastern Europe, northern Africa, the Near East and Arabia, into southern Russia (Hoogstraal and Kaiser, in press).

Hyalomma dromedarii Koch, 1844. The Camel Hyalomma.

Hodeida area, sea level to 100 ft. alt.: 297 males, 210 females, off domestic camels; 47 males, 62 females, off domestic cattle (for slaughter).

Ta'izz area, 4100 ft. alt.: 536 males, 405 females, off domestic camels; 90 males, 77 females, off domestic cattle; 42 males, 48 females, off domestic goats; 4 males, 4 females, off domestic dogs; 1 male, off domestic sheep.

Ma'bar area, 7400 ft. alt.: 1 male, 1 female, off domestic goats.

San'a area, 7100 ft. alt.: 3 males, 6 females, off domestic camels; 38 males, 34 females, off domestic cattle.

As stated for *H. a. anatolicum*, it appears that January and February are within the breeding season of *H. dromedarii* at various levels in the Yemen. The 4 pairs of *H. dromedarii* taken on domestic dogs at Ta'izz are of some interest, inasmuch as this tick infrequently parasitizes carnivores. Members of Yemeni populations are smaller in size than those commonly found elsewhere in the geographic range of this tick.

Hyalomma impeltatum impeltatum Schulze and Schlotzke, 1930.
Kratz's Hyalomma.

Hodeida area, sea level to 100 ft. alt.: 49 males, 143 females, off domestic camels; 66 males, 53 females, off domestic cattle (for slaughter); 1 male, off domestic sheep.

Ta'izz area, 4100 ft. alt.: 11 males, 14 females, off domestic camels; 28 males, 9 females, off domestic cattle; 1 male, off domestic sheep; 1 male, off domestic dog.

San'a area, 7100 ft. alt.: 1 male, 16 females, off domestic camels; 11 males, 6 females, off domestic cattle.

As in the previous two *Hyalomma* species, note the high proportion of females. These data also suggest that *H. i. impeltatum* may be more numerous in the lowlands than in the mountains of the Yemen. Remarks concerning the small size of Yemeni specimens of *H. dromedarii* apply equally to those of *H. i. impeltatum*. Yemeni populations do not show the characters of the subspecies *somalicum* Tonelli-Rondelli, which was recently found (Hoogstraal and Kaiser,

in press) to be a valid subspecies of *H. impeltatum*. It is possible that owing to the exceptionally small size of individuals in Yemeni populations, these subspecific criteria are obscured.

Hyalomma rufipes Koch, 1844. The Hairy Hyalomma.

Hodeida area, sea level to 100 ft. alt.: 1 male, 2 females, off domestic cattle (for slaughter); 1 male, off domestic sheep.

Ta'izz area, 4100 ft. alt.: 68 males, 64 females, off domestic camels; 63 males, 33 females, off domestic cattle; 3 males, 2 females, off domestic dogs; 1 male, off human being (engorging on).

Ma'bar area, 7400 ft. alt.: 10 males, 3 females, off domestic goats.

San'a area, 7100 ft. alt.: 53 males, 38 females, off domestic cattle.

The fact that this was the predominant species taken on San'a cattle suggests predilection of *H. rufipes* for high altitude under conditions in the Yemen. The high ratio of females in these collections suggests that January and February are in the breeding season of this species in the Yemen.

Hyalomma spp.

Hodeida area, sea level to 100 ft. alt.: 15 larvae, 26 nymphs, off *Gerbillus cheesmani maritimus* (10); 312 larvae, 452 nymphs, off *Lepus arabis* subsp. (6); 1 nymph, off *Rattus r. rattus* (commensal); 26 nymphs, off domestic camels.

Ta'izz area, 4100 ft. alt.: 6 nymphs, off *Vulpes v. arabica* (Jebel Zarba, 7000 ft. alt.); 17 larvae, 32 nymphs, off *Lepus a. arabis*; 16 larvae, off *Acomys dimidiatus homericus* (9); 28 nymphs, off domestic cattle; 225 nymphs, off domestic camels.

San'a area, 7100 ft. alt.: 1 nymph, 6 females, off domestic cattle; 2 nymphs, off domestic camel.

Unfortunately, satisfactory diagnostic criteria for immature hyalommas have not yet been established. The epidemiological significance of the data presented above would be much enhanced if these ticks could be identified to species. Note the tremendous infestations of hares and the significant rate of parasitism of gerbils and camels by immature hyalommas.

Ixodes hoogstraali Arthur, 1955. The Yemeni Russet Tick. Figure 51.

Six miles south of Ma'bar, 7400 ft. alt.: 22 females, off *Meriones rex buryi* (3).

I. hoogstraali is known only from the 22 female specimens listed above. Closely related to *I. ugandanus* Neumann, 1906, of East Africa, it is tentatively considered as a species of Ethiopian Faunal Region affinities and endemic in the higher mountains of south western Arabia. No other species in this genus are known from Arabia.

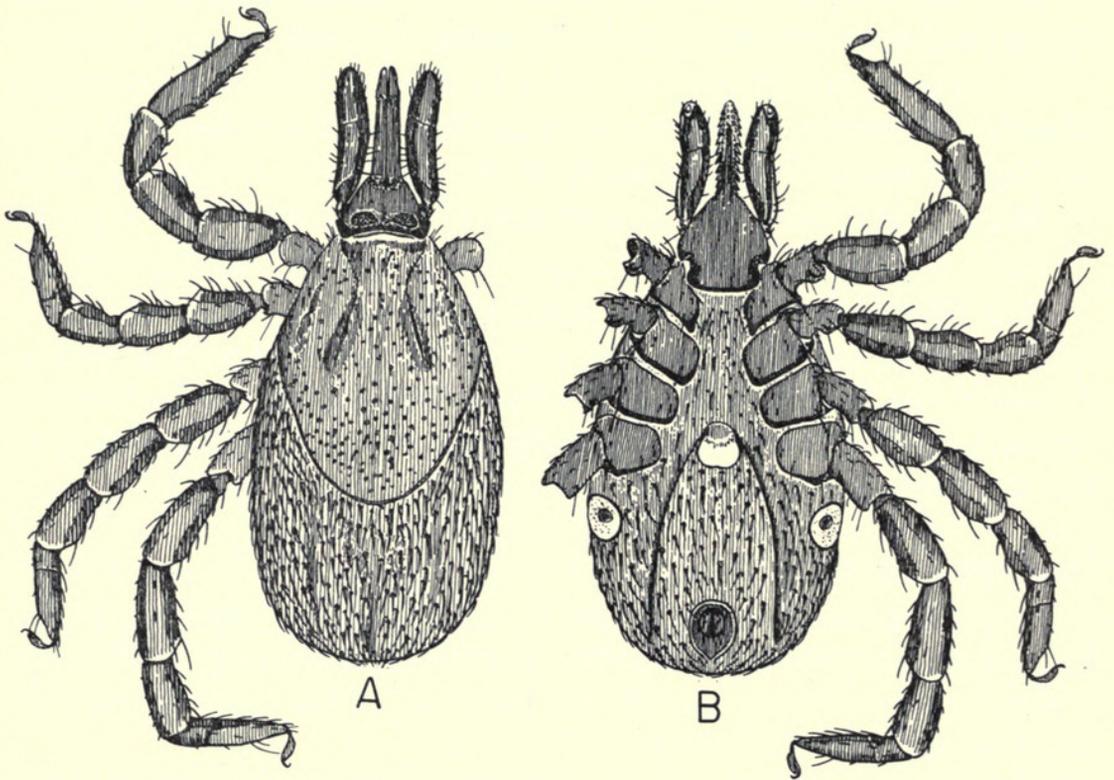


FIG. 51. *Ixodes hoogstraali* Arthur, paratype: A, dorsal view; B, ventral view. Ma'bar area.

Males of this tick will probably be easily found in the burrows or nests of *Meriones rex buryi* near Ma'bar. Males either do not feed or feed for only short periods of time, and probably seldom if ever leave the host's burrow.

Diagnosis (female).—A pale brown species with dark brown scutum, legs, and capitulum. Unfed individuals measure 2.3 mm. in length; when engorged they measure up to 5.2 mm.

| SCUTUM lozenge-shaped, widest anterior to mid-level, narrowing postero-laterally and abruptly rounded posteriorly; 1.01 mm. long, 0.73 mm. wide. Surface finely punctate with few, short, white hairs anteriorly. Cervical grooves extending beyond mid-level of scutum, converging anteriorly, thence diverging. Lateral carinae pronounced anteriorly, extending to posterior third of scutum.

CAPITULUM: *Basis capituli* dorsally mildly convex, faintly crazed, impunctate, lacking hairs; porose areas superficial, subtriangular; posterior margin straight or slightly concave with short, broadly rounded postero-lateral junctures in place of cornua; postero-lateral margin short, slightly divergent; ventrally lateral margins acutely divergent from anterior margin to mid-length; with broad, retrograde auriculae; thence with parallel lateral margins extending to slightly convex posterior margin. *Palpi* reaching apex of hypostome; outer margin concave, inner margin convex, paralleling outer margin; segment 2 slightly longer than segment 3, combined length of these two segments 5 times width. *Hypostome* approximately 0.38 mm. in length; moderately wide, apex rounded; small corona present; dentition 2/2 in six files, 3/3 in three or four files, and 4/4 in one to three files.

INTEGUMENT with numerous, long, curved white hairs. *Genital aperture* situated between coxae IV when unengorged, just anterior to this level when engorged. *Genital grooves* narrowly rounded anterior to genital aperture, gradually divergent posteriorly and extending to posterior margin of body. *Anus* situated near posterior margin of body. *Anal groove* circular, posteriorly with a slightly elongated, triangular juncture. *Spiracular plates* oval, transversely elongate, approximately equaling coxae IV in size.

LEGS: *Coxae* not syncoxae; I with a short, broad internal spur, II and III unarmed, IV with a very small external spur. *Tarsus* I gradually tapering beyond haller's organ; tarsus IV abruptly tapered from near base to apex.

Male, nymph, and larva unknown.

Note: Illustrations and characters for identifying this species are provided here only because they are not included in the easily available generic reviews commonly used for identifying African and Near Eastern ticks.

Rhipicephalus evertsi evertsi Neumann, 1897. The Red Tick.

Ta'izz area, 4100 ft. alt.: 4 nymphs, off *Lepus a. arabicus*; 68 males, 60 females, off domestic cattle; 14 males, 10 females, off domestic camels; 2 males, off domestic donkey; 2 females, off domestic dog.

Ma'bar, 7400 ft. alt.: 1 male, off domestic cattle.

Immature stages of this tick usually parasitize larger animals, on which adults also feed. A number of records of larvae and nymphs on smaller animals, especially hares, are extant, though difficult to explain (Hoogstraal, 1956, pp. 647-648).

Rhipicephalus simus simus Koch, 1844. The Glossy Tick.

Ta'izz area, 4100 ft. alt.: 5 nymphs, off *Mus musculus bactrianus* (feral) (2); 13 nymphs, off *Meriones rex buryi* (7); 23 nymphs, off *Acomys dimidiatus homericus* (3); 3 larvae, 8 nymphs, off *Arvicanthis niloticus naso*; 55 males, 104 females, off domestic cattle; 8 males, 17 females, off domestic camels; 1 male, 1 female, off domestic dog.

The large number of *R. s. simus* taken on cattle in the Yemen is of some interest (Hoogstraal, 1956, pp. 737-738).

Rhipicephalus sanguineus sanguineus (Latreille, 1806). The Kennel Tick.

Hodeida area, sea level to 100 ft. alt.: 5 nymphs, off *Suncus murinus sacer* (3) (commensal); 2 larvae, 1 nymph, off *Mus musculus bactrianus* (commensal) (2); 2 nymphs, off *Rattus r. rattus* (commensal); 5 larvae, 2 nymphs, off *Gerbillus cheesmani maritimus*; 16 larvae, 16 nymphs, off *Lepus arabicus* subsp.; 1 male, 1 female, off *Hyaena h. sultana* (captive); 1 male, 1 female, off human being (engorging on); 7 males, 7 females, off domestic dogs; 3 males, 3 females, off domestic cats (all *R. secundus* Feldman-Muhsam); 2 males, off domestic camel.

Ta'izz area, 4100 ft. alt.: 1 nymph, off *Rattus r. rattus* (commensal); 7 nymphs, 5 males, 4 females, off *Lepus a. arabicus* (1 female *R. secundus*); 16 males, 22 females, off *Vulpes v. arabica* (Jebel Zarba, 7000 ft. alt.) (females *R. secundus*); 15 males, 15 females, off *Gazella g. arabica* (3) (4 females *R. secundus*); 1 female, off human being (engorging on); 44 males, 40 females, off domestic cattle (24 females *R. secundus*); 9 males, 1 female, off domestic camels; 10 males, 6 females, off domestic dogs; 1 male, 1 female, off domestic sheep; 1 male, 2 females, off domestic goats.

Ma'bar, 7400 ft. alt.: 1 male, 1 female, off *Vulpes v. arabica* (female *R. secundus*); 1 male, off domestic cattle.

San'a, 7100 ft. alt.: 4 males, 4 females, off domestic cattle.

Yemen specimens presented to American institutions were obtained by Dr. B. Feldman-Muhsam who returned a number of them labeled *R. secundus* Feldman-Muhsam, as noted in parentheses above. We are unable to distinguish this species among non-Palestinian populations of *R. s. sanguineus*.

HOSTS OF TICKS IN THE YEMEN

SNAKES

Psammophis schokari (Forskål, 1775)

A male *Aponomma latum* was removed from this snake at Ta'izz, but no other snakes (13 specimens representing 5 species) were found infested in the Yemen.

LIZARDS

Agama adramitana Anderson, 1896

One of these lizards near Ta'izz bore 2 larvae and 21 nymphs of *Haemaphysalis sulcata*. Sixty-eight others taken near Ta'izz were free of ticks.

Eremias guttulata guttulata (Lichtenstein, 1823)

Two of 71 specimens examined from Ta'izz, Ma'bar, and San'a were infested; these 2, from Ma'bar, yielded 2 larvae and 14 nymphs of *Haemaphysalis sulcata*.

Acanthodactylus boskianus asper (Audouin, 1827)

Two larvae of *Haemaphysalis sulcata* were found on this lizard near Ta'izz. Ninety-three other lizards of this form, examined near Ta'izz and Hodeida, were free of ticks.

COMMENSAL MAMMALS

Suncus murinus sacer Ehrenberg, 1833

Three of the 25 shrews examined from the bazaars of Hodeida, where they are extremely numerous, yielded a total of 5 nymphs of *Rhipicephalus s. sanguineus*.

Rattus rattus rattus (Linnaeus, 1758)

Commensal rats appear rarely to be hosts of ticks. Only 3 nymphs of *Rhipicephalus s. sanguineus* and one of *Hyalomma* sp. were found on the 54 animals examined in the Yemen.

Mus musculus bactrianus Blyth, 1846

Three immature *Rhipicephalus s. sanguineus* infested 2 mice from the Hodeida bazaars, but no ticks were found on city mice at Ma'bar (2) or San'a (19).

FERAL MAMMALS

Vulpes vulpes arabica Thomas, 1902

An Arabian fox from 7000 feet altitude on Jebel Zarba, near Ta'izz, was infested by 2 nymphal *Amblyomma variegatum*, 6 nymphal *Hyalomma* sp., 38 adult *Rhipicephalus s. sanguineus*, 2 males of *Haemaphysalis l. leachii*, and 3 males and a female of *H. leachii muhsami*. The second specimen, near Ma'bar, yielded 2 adult *R. s. sanguineus*.

Hyaena hyaena sultana Pocock, 1934

The only hyena examined, trapped a few weeks earlier on the outskirts of Hodeida, bore 2 adult *Rhipicephalus s. sanguineus*.

Lepus arabicus arabicus Ehrenberg, 1833

Although this hare is common around Ta'izz, we obtained only a single specimen at El Hauban in Wadi Maleh, 3900 feet elevation. It was infested by 14 immature *Amblyomma variegatum*, 49 immature *Hyalomma* spp., 4 nymphal *Rhipicephalus e. evertsi*, and 7 nymphs and 9 adults of *R. s. sanguineus*. If this single animal is a satisfactory indication, hares in the Ta'izz area may be considered as important tick hosts.

Lepus arabicus subsp.

Six hares were taken among sand hummocks in the scattered shrub coastal plain desert around Hodeida, where they are exceedingly numerous. These 6 hosts, which yielded a female *Hyalomma a. anatolicum*, 764 immature *Hyalomma* spp., and 32 immature *Rhipicephalus s. sanguineus*, indicate that hares of the coastal plain are indeed significant hosts of ticks.

Arvicanthis niloticus naso Pocock, 1934

In the Ta'izz area, 6 grass rats bore a nymphal *Haemaphysalis leachii* subsp. and 11 immature *Rhipicephalus s. simus*.

Mus musculus bactrianus Blyth, 1846

The 2 feral specimens of mice taken on this mission were trapped at a termite mound in an acacia thicket bordering a seepage area in Wadi Maleh, 7 miles east of Ta'izz, 3700 feet elevation. On them was found a larval *Ornithodoros* sp., and 5 nymphal *Rhipicephalus s. simus*.

Acomys dimidiatus homericus Thomas, 1923

Nine spiny mice were taken in fields and rocky outcrops within 7 miles of Ta'izz. These yielded 13 immature *Haemaphysalis leachii* subsp., 16 larval *Hyalomma* spp., and 23 nymphal *Rhipicephalus s. simus*. Thus, with an average of more than 5 parasites per animal, *Acomys* mice appear to be of some importance as hosts of immature ticks in the Ta'izz area.

Gerbillus cheesmani maritimus Sanborn and Hoogstraal, 1953

Ticks on the 10 gerbils caught from five to thirteen miles south-east of Hodeida among the hummocks on the coastal desert were 41 immature *Hyalomma* spp. and 7 immature *Rhipicephalus s. sanguineus*. Gerbils undoubtedly play an important role in maintaining the immature stages of certain ticks on the coastal desert.

Meriones rex buryi Thomas, 1902

Three of the 5 specimens of jirds taken in the fields around Ma'bar (7400 feet altitude) were infested by 22 females of *Ixodes hoogstraali* and 7 others in the Ta'izz area by 13 nymphal *Rhipicephalus s. simus*. No ticks were found on 4 jirds near San'a.

Gazella gazella arabica (Hemprich and Ehrenberg, 1827)

Three of the 5 gazelles obtained near Ta'izz bore 4 nymphs and a misformed male of *Amblyomma variegatum* and 15 pairs of adult *Rhipicephalus s. sanguineus*.

HUMAN BEINGS

Three *Rhipicephalus s. sanguineus* were removed while engorging on members of our party, a male and a female tick at Hodeida and a female near Ta'izz. In the latter area, single males of *Amblyomma variegatum* and *Hyalomma rufipes* were taken in the same circumstances.

DOMESTIC ANIMALS

Camels

Ticks removed from camels in the coastal lowlands around Hodeida were 507¹ *Hyalomma dromedarii* (a large number of which were

¹ Numbers refer to adult specimens unless otherwise specified.

engorging females), 542 *H. a. anatolicum* (over half of which were engorging females), 192 *H. i. impeltatum* (approximately four-fifths of which were engorging females), 26 nymphal *Hyalomma* spp., and 2 *Rhipicephalus s. sanguineus*. Large numbers of *Ornithodoros savignyi* were also obtained from sand in the shade of a tree beside a camel trail near Hodeida. Around Ta'izz, at about 4000 feet elevation, camels yielded 25 *Amblyomma variegatum*, 49 *Boophilus annulatus*, 1730 *Hyalomma a. anatolicum*, 11 *H. anatolicum excavatum*, 941 *Hyalomma dromedarii*, 25 *H. i. impeltatum*, 132 *H. rufipes*, 225 nymphal *Hyalomma* spp., 24 *Rhipicephalus e. evertsi*, 25 *R. s. simus*, and 10 *R. s. sanguineus*. As at Hodeida, a large proportion of the hyalommas were engorging females and numerous *Ornithodoros savignyi* were found under a tree beside a camel trail. Higher in the mountains, fewer camels were examined. At San'a (about 7000 feet altitude), we took 9 *H. a. anatolicum*, 9 *H. dromedarii*, 17 *H. i. impeltatum* (including only a single male), and 2 nymphal *Hyalomma* sp.

Yemeni camels are heavily tick-infested and more formal collections from them should yield much valuable data concerning tick biology in the Yemen.

Cattle

Cattle are not maintained in the coastal desert in the Hodeida area but numerous ticks are introduced on those brought for slaughter. Cattle are common in many localities higher in the mountains. In the vicinity of Ta'izz, cattle yielded the single *Amblyomma gemma* (a male) taken during this mission, 84 nymphs and 194 adults of *A. variegatum*, 29 males and 804 females of *Boophilus annulatus*, 2 male *Haemaphysalis sulcata*, 489 *Hyalomma a. anatolicum*, 13 *H. anatolicum excavatum*, 167 *H. dromedarii*, 37 *H. i. impeltatum*, 96 *H. rufipes*, 28 nymphal *Hyalomma* spp., 128 *Rhipicephalus e. evertsi*, 159 *R. s. simus*, and 84 *R. s. sanguineus*. Around Ma'bar (7400 feet altitude), 4 *Amblyomma variegatum*, 1 *Boophilus annulatus*, 4 (male) *Haemaphysalis sulcata*, 1 *Rhipicephalus e. evertsi*, and 1 *R. s. sanguineus* were found on cattle. At San'a (7100 feet altitude), cattle yielded 72 *Hyalomma dromedarii*, 17 *H. i. impeltatum*, 91 *H. rufipes*, 7 *Hyalomma* spp., and 8 *Rhipicephalus s. sanguineus*. Although cattle at Ma'bar and San'a were noticeably freer of ticks than those at Ta'izz, opportunities for collecting from these animals were much poorer at Ma'bar and San'a than they were at Ta'izz, and the data have little or no quantitative significance. The disproportionately high number of *Hyalomma rufipes* taken at San'a, however, is noteworthy.

Goats

Less attention was paid to goats and sheep than to camels and cattle. At Ta'izz, 3 *Boophilus annulatus*, 196 *Hyalomma a. anatolicum*, 90 *H. dromedarii*, and 3 *Rhipicephalus s. sanguineus* were found on goats. Twenty-one *Hyalomma a. anatolicum* were taken from goats at Ma'bar and 12 of the same tick at San'a, while at Ma'bar 13 *Hyalomma rufipes* were also collected.

Sheep

Two *Boophilus annulatus*, 1 *Hyalomma dromedarii*, 1 *H. i. impeltatum*, and 2 *Rhipicephalus s. sanguineus* parasitized sheep at Ta'izz. A few sheep at Hodeida yielded 11 male *Hyalomma a. anatolicum* and single males of *H. i. impeltatum* and *H. rufipes*.

Dogs

A male *Amblyomma variegatum*, 2 female *Boophilus annulatus*, 17 *Hyalomma a. anatolicum*, 8 *H. dromedarii*, 1 *H. i. impeltatum*, 5 *H. rufipes*, 2 *Rhipicephalus e. evertsi*, 2 *R. s. simus*, and 16 *R. s. sanguineus* parasitized the few dogs examined at Ta'izz, indicating a remarkably high rate and variety of tick infestation in this area. At Hodeida, 14 *R. s. sanguineus* were taken from a few dogs.

Cats

Three cats examined at Hodeida yielded 6 *R. s. sanguineus*.

Donkey

Two male *R. e. evertsi* were found on a donkey at Ta'izz.

WILD MAMMAL SPECIES NEGATIVE FOR TICKS

Species	Locality	Number examined
<i>Eidolon sabaeum</i> (Anderson)	Ta'izz	1
<i>Nycteris capensis damarensis</i> Peters	San'a, Al'Asr	28
<i>Hipposideros caffer caffer</i> (Sundevall)	San'a (near)	2
<i>Rhinolophus clivosus acrotis</i> Heuglin	Ta'izz	25
<i>Rhinolophus clivosus acrotis</i> Heuglin	San'a, Al'Asr	1
<i>Rhinolophus blasii</i> Peters	Ma'bar (near)	1
<i>Rhinolophus blasii</i> Peters	San'a, Al'Asr	99
<i>Pipistrellus kuhlii kuhlii</i> (Kuhl)	Ma'bar	1
<i>Pipistrellus kuhlii kuhlii</i> (Kuhl)	San'a	3
<i>Chaerophon pumilis pumilis</i> (Cretzschmar)	Hodeida, Bajil	7
<i>Myomys fumatus yemeni</i> Sanborn and Hoogstraal	San'a (near)	3

<i>Rattus rattus rattus</i> (Linnaeus) ¹ (commensal)	San'a	19
<i>Mus musculus bactrianus</i> Blyth (commensal)	Ma'bar	1
<i>Mus musculus bactrianus</i> Blyth (commensal)	San'a	19
<i>Gerbillus (Dipodillus) famulus</i> Yerbury and Thomas	Ma'bar	6
<i>Gerbillus (Dipodillus) famulus</i> Yerbury and Thomas	Ta'izz area	6
<i>Meriones rex buryi</i> Thomas ¹	San'a area	4
<i>Gazella dorcas saudyia</i> Carruthers and Schwarz	Ma'bar area	2
<i>Procarvia syriaca jayakari</i> Thomas	Ta'izz area	5

TICKS OF OTHER ARABIAN AREAS

Arabia (fig. 52) is here considered as Transjordan, Muscat, Oman, Saudi Arabia, Kuwait, Bahrein, Qatar, Trucial Oman, Yemen, and Aden (Aden Colony and Aden Protectorate). It may be of interest to add that in the states north of Arabia, the tick fauna of Palestine is moderately well known, a report on that of Iraq by the present writers is in press in the Iraqi Journal of Medical Sciences, and knowledge of ticks in Syria and Lebanon is meager.

Although the tick fauna of Arabia, except in the Yemen, is far from rich in variety, there is little doubt that a number of already described species await discovery there. Practically nothing is known of the Arabian tick fauna outside of the Yemen. The following records are available, chiefly from the Hoogstraal collection.

TRANSJORDAN

The only tick data from Transjordan result from collections made by Professor B. Babudieri of Rome, in his capacity as special consultant for the World Health Organization. Professor Babudieri brought his collections to us for identification. These data have been briefly discussed in mimeographed reports (Babudieri, 1954, 1955).

Argas persicus

The fowl tick was found in a number of localities, including Amman.

Argas sp. (*reflexus* group)

Professor Babudieri kindly presented us with four specimens taken at El Azraq, an oasis east of Amman, from dust in a hole in a wall in which a mongoose ("Civetta" according to the Professor) lived. We are presently gathering material for a revision of this group based on collections from many parts of the world and are unable at the

¹ Tick-infested hosts of this subspecies were found in other areas of the Yemen.

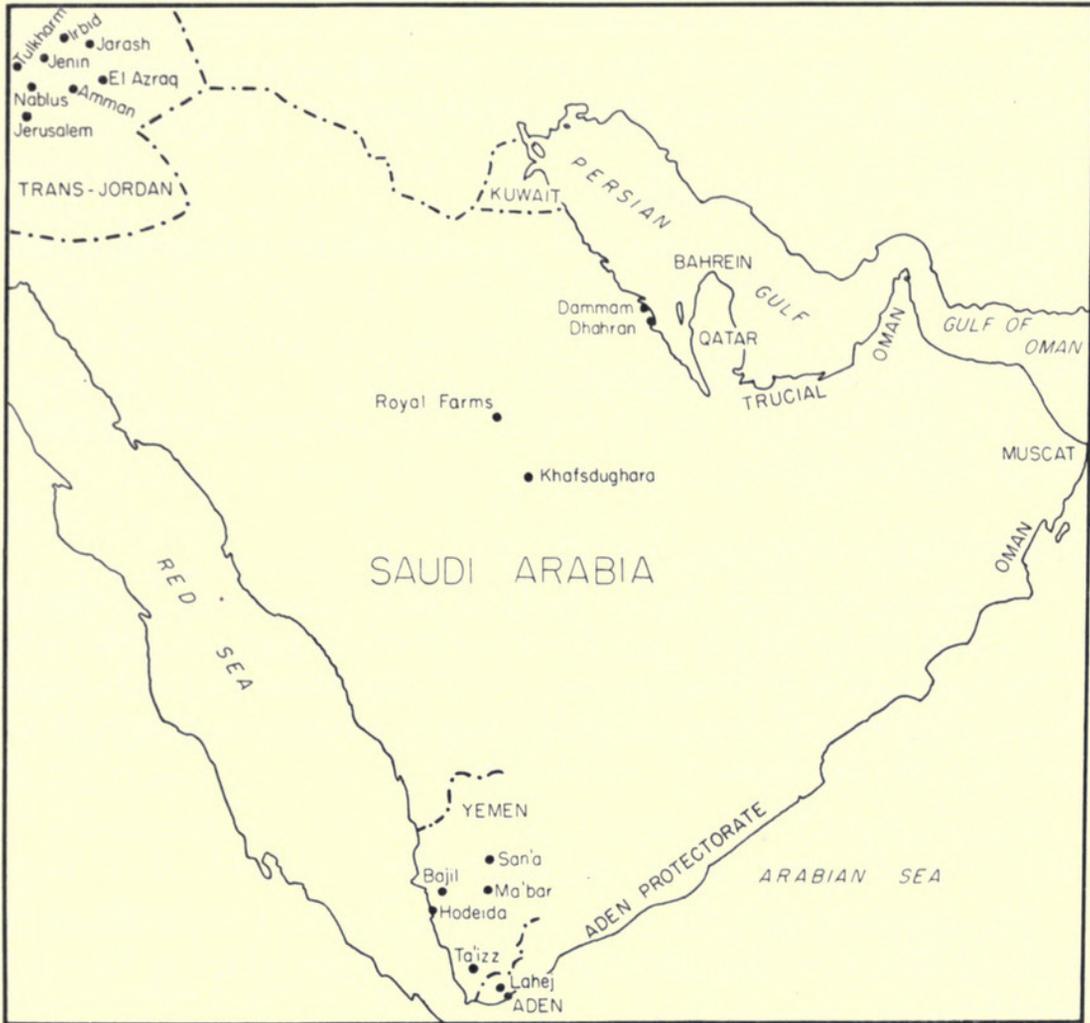


FIG. 52. Map of Arabia, showing political divisions and localities mentioned in text.

present time to venture a guess on the systematic status of these specimens.

***Ornithodoros coniceps* (Canestrini, 1890)**

Large numbers of spirochete-infested specimens were found in houses and stables in Nablus and elsewhere in Marda District, where they feed on chickens and people. Some of these ticks were used for the life-cycle studies reported by Davis and Mavros (1956). The literature on this species has been listed by Hoogstraal (1956, p. 115).

***Ornithodoros t. tholozani* Laboulbene and Megnin, 1882**

Numerous spirochete-infested specimens were found in caves in Irbid (5 caves), Jarash (1 cave), Madaba (1 cave), Jenin (1 cave), Tulkharm (2 caves), and Jerusalem (1 cave) (Babudieri, 1954). Spi-

rochetes from some of these populations of this important relapsing fever vector were tested comparatively with others from Egypt, U.S.S.R., and Palestine by Davis and Hoogstraal (1956).

Hyalomma a. anatolicum

“This species (as *H. excavatum*) is particularly numerous in the eastern desert.” (Babudieri, 1954.)

Rhipicephalus s. sanguineus

Professor Babudieri returned with many specimens of the kennel tick from Transjordan.

Ornithodoros erraticus (Lucas, 1849)

“It should be noted that contrary to what happens in . . . Egypt and North Africa, I have (not) found ticks of the genus *Ornithodoros* in the burrows of sylvatic rodents (in Transjordan).” (Babudieri, 1954.) This remark would indicate that *O. erraticus* is absent or at least rare and localized in Transjordan.

MUSCAT

The following material, identified by us for the British Museum (Natural History), was collected by Mr. W. Lethbridge in November, 1906.

Hyalomma a. anatolicum

Muscat: 2 males, 2 females, from cow. Matera, Muscat: 2 males, 2 females, from horse.

Hyalomma dromedarii

Multra near Muscat: 5 females, from camel. Muscat: 1 female, from cow.

TRUCIAL OMAN

Hyalomma a. anatolicum

We have seen several specimens of this tick from Trucial Oman, without further data.

OMAN, QATAR, KUWAIT, AND BAHREIN

No tick records are available from these areas.

SAUDI ARABIA

Hyalomma a. anatolicum

Khafsdughara: 85 males, 28 females, off domestic camels, April 5, 1954, J. B. Mimms; 26 males, 22 females, off domestic cattle, April 5, 1954, J. B. Mimms; 11 males, 2 females, off Jersey bull, February 8, 1954, J. B. Mimms; 75 males, 10 females, off domestic horses, April 5, 1954, J. B. Mimms.

Al Karji Royal Farms: 14 males, 6 females, off dairy cattle, April 20, 1954, J. B. Mimms; 7 females, off steer, April 30, 1954, J. B. Mimms.

Dammam: 1 male, 14 females, off domestic horses, July 24, 1950, R. H. Daggy.

Dhahran: 3 males, 2 females, off domestic horses, July 1, 1950, R. H. Daggy.

Hyalomma dromedarii

Dammam: 5 males, 1 female, off domestic camels, July 24, 1954, R. H. Daggy.

Khafsdughara: 19 males, 7 females, off domestic camels, April 5, 1954, J. B. Mimms; 1 female, off domestic cattle, April 5, 1954, J. B. Mimms.

Hyalomma i. impeltatum

Dammam: 9 males, 6 females, off domestic camels, July 24, 1950, R. H. Daggy.

Hyalomma spp.

Dammam: 24 nymphs, off domestic camels, July 24, 1950, R. H. Daggy.

Khafsdughara: 4 nymphs, off domestic horses, April 5, 1954, J. B. Mimms.

Dhahran: 58 nymphs, off domestic horses, July 1, 1950, R. H. Daggy.

Al Karji Royal Farms: 32 larvae, off dairy cattle, April 20, 1954, J. B. Mimms.

"SOUTHERN ARABIA"

The following localities, from labels of material identified by Hoogstraal from collections of the British Museum (Natural History), cannot be more closely defined.

Aponomma gervaisi Lucas, 1847

El Kubar, Amini country: 1 male, from *Varanus ocellatus*.

Gebel Baringo: 1 female, 10 nymphs, from *V. ocellatus*, Sir H. Johnstone, collector.

Identification of these Oriental lizard ticks was confirmed by Dr. G. Theiler. However, the status of various populations referable to this species is moot and likely to further change. At any rate, it is of interest that the *Aponomma* parasite of snakes in southern Arabia is a species endemic to the Ethiopian Faunal Region while that of *Varanus* lizards is an Oriental form.

Amblyomma variegatum

Ain, southern Arabia: 1 male, from Arabian wolf, *Canis lupus arabs*, B. S. Thomas, collector. This unusual host and locality record has been reported by Hoogstraal (1954).

ADEN (COLONY AND PROTECTORATE)

Ornithodoros savignyi

Specimens, probably from in or near Aden colony, have been reported by Nuttall *et al.* (1908), Patton and Cragg (1913), and Cunliffe (1922). During the Yemen mission, Hoogstraal collected a number of nymphs and adults from under a tree on a camel trail between Aden and Lahej.

Hyalomma a. anatolicum

Two males were taken from cattle and 1 female from a camel at Aden after returning from the Yemen.

Hyalomma dromedarii

Many specimens were taken from camels at Aden after we returned from the Yemen mission, and collections in the British Museum (Natural History) contain many specimens also taken from camels at Aden.

Rhipicephalus s. sanguineus

Schulze (1936, 1941) reported specimens from Aden under the synonymous name *R. macropis*, new sp.

Six males and 3 females were taken from a domestic dog at Lahej (January, Hoogstraal) while we were en route to the Yemen.

ACKNOWLEDGMENTS

No report of results of the United States Navy Medical Mission to the Yemen is complete without acknowledgment of thanks due to all levels of the Yemen government for material assistance and hospitality, to Judge Jasper Brinton of the American Embassy, Cairo, for diplomatic arrangements for this mission, and to Mr. Abdel Aziz Salah of NAMRU 3, whose efforts as liaison officer considerably enhanced the success of the mission.

SUMMARY

Data are provided for the following species of ticks taken in the Yemen during the United States Naval Medical Mission to the Yemen, 1951: *Argas persicus*, *Ornithodoros savignyi*, *O. sp.*, *Amblyomma gemma*, *A. variegatum*, *Aponomma latum*, *Boophilus annulatus*, *Hae-maphysalis l. leachii*, *H. leachii muhsami*, *H. leachii* subsp. *H. sulcata*, *Hyalomma a. anatolicum*, *H. anatolicum excavatum*, *H. dromedarii*, *H. i. impeltatum*, *H. rufipes*, *H. spp.*, *Ixodes hoogstraali*, *Rhipicephalus e. evertsi*, *R. s. simus*, and *R. s. sanguineus*. Other literature on results of this Mission is also listed. The present Yemen collection consists of 9178 specimens, of which 7538 (approximately 82 per cent) are *Hyalomma* species.

The following tick species are known from the other political areas of Arabia: TRANSJORDAN: *Argas persicus*, *A. sp.* (*reflexus* group), *Ornithodoros coniceps*, *O. t. tholozani*, *Hyalomma a. anatolicum*, and *Rhipicephalus s. sanguineus*. MUSCAT: *Hyalomma a. anatolicum* and *H. dromedarii*. TRUCIAL OMAN: *H. a. anatolicum*. OMAN, QATAR, KUWAIT, and BAHREIN: None. SAUDI ARABIA: *H. a. anatolicum*, *H. dromedarii*, *H. i. impeltatum*, *H. spp.* "SOUTHERN ARABIA": *Aponomma gervaisi* and *Amblyomma variegatum*. ADEN (COLONY and PROTECTORATE): *Ornithodoros savignyi*, *Hyalomma dromedarii*, *H. a. anatolicum*, *Rhipicephalus s. sanguineus*.

REFERENCES

ARTHUR, D. R.

1955. *Ixodes hoogstraali*, a new species of tick from Yemen. *Parasitology*, **45**, (1-2), pp. 128-130.

BABUDIERY, B.

1954. Survey on relapsing fever in Jordan, July-September 1954. Preliminary report. WHO (Alexandria), EM/Epid/3 (Jordan 12), mimeographed. 5 pp.
 1955. Survey on relapsing fever in Jordan, July-September 1954. Final report. WHO (Alexandria), EM/Epid/3 (Jordan 12), mimeographed. Add. 1, 3 pp.

CUNLIFFE, N.

1922. Some observations on the biology and structure of *Ornithodoros savignyi*, Audouin. *Parasitology*, **14**, (1), pp. 17-26.

DAVIS, G. E., and HOOGSTRAAL, H.

1956. The relapsing fevers: a survey of tick-borne spirochetes in Egypt. *Atti VI Cong. Internaz. Microbiol.*, **5**, (1953), pp. 24-25 (abstract).

DAVIS, G. E., and MAVROS, A. J.

1956. Concerning the life cycle of *Ornithodoros coniceps* (Canestrini, 1890) (Ixodoidea, Argasidae). *Jour. Egypt. Public Health Assn.*, **31**, (1), pp. 55-59.

DÖNITZ, W.

1909. Über das Zeckengenus *Amblyomma*. *Berlin Sitzber. Ges. Naturf. Freunde*, **1909**, (8), pp. 440-482.

FRANCHINI, G.

1930. Distribuzione degli ixodidi nello Yemen (Arabia meridionale). *Reperto di spirochete nei pidocchi della citta di Sana*. *Arch. Ital. Sci. Med. Colon.*, **11**, (8), pp. 449-452.

GIROLAMI, M.

1952. Considerazioni mediche su un viaggio nello Yemen. *Arch. Ital. Sci. Med. Trop. Parasit.*, **33**: 355-404, 21 figs., 1 map.

GRIMALDI, V.

1934. Gli ixodid delle Colonie Italiane e le malattie da essi transmesse. *Arch. Ital. Sci. Med. Colon.*, **15**, (7), pp. 504-513.

HOOGSTRAAL, H.

1952. Yemen opens the door to progress. *Nat. Geog. Mag.*, **101**, (2), pp. 213-244.

1954. Noteworthy African tick records in the British Museum (Natural History) collections (Ixodoidea). *Proc. Ent. Soc. Washington*, **56**, (6), pp. 273-279.

1956. African Ixodoidea. 1. Ticks of the Sudan (with special reference to Equatoria Province and with preliminary reviews of the genera *Boophilus*, *Margaropus*, and *Hyalomma*). 1101 pp., U. S. Navy, Washington, D.C.

(In press.) Geographic and individual variation in the Middle East lizard haemaphysalid, *Haemaphysalis sulcata* Canestrini and Fanzango, 1878 (Ixodoidea, Ixodidae).

HOOGSTRAAL, H. (*Editor*)

(In preparation.) Studies on East African ticks, other ectoparasites, and their hosts; based on materials and data collected by the Scientific Working Party on Ectoparasites and Arthropod-borne Diseases sponsored by the United States Naval Medical Research Unit (Cairo) and the East African Veterinary Research Organization (Muguga, Kenya), 1956. U. S. Navy.

HOOGSTRAAL, H., and KAISER, M. N.

(In press.) Observations on Egyptian *Hyalomma* ticks (Ixodoidea, Ixodidae). 5. Biological notes and differences in identity of *H. anatolicum* and its subspecies *anatolicum* Koch and *excavatum* Koch among Russian and other workers. Identity of *H. lusitanicum*.

(In press.) Recent developments in systematics of *Hyalomma* ticks, with keys to species (Ixodoidea, Ixodidae).

JOBLING, B.

1958. Streblidae from Yemen, with description of one subspecies of *Ascodipteron* (Diptera). *Fieldiana: Zool.*, **39**, (17), pp. 185-189.

KNIGHT, K. L.

1953a. Two new species of mosquitoes from the Yemen (Diptera: Culicidae). *Jour. Washington Acad. Sci.*, **43**, (10), pp. 320-325.

1953b. The mosquitoes of the Yemen (Diptera, Culicidae). *Proc. Ent. Soc. Washington*, **55**, (5), pp. 212-234.

KUNTZ, R. E.

1952. *Schistosoma mansoni* and *S. hematobium* in the Yemen, southwest Arabia, with a report on an unusual factor in the epidemiology of schistosomiasis mansoni. *Jour. Parasit.*, **38**, (1), pp. 24-28.

KUNTZ, R. E., MALAKATIS, G. M., LAWLESS, D. K., and STROME, C. P. A.

1953. Medical mission to the Yemen, southwest Arabia, 1951. II. A cursory survey of the intestinal protozoa and helminth parasites in the people of the Yemen. *Amer. Jour. Trop. Med. Hyg.*, **2**, (1), pp. 13-19.

MACY, R. W.

1953. First report of the human intestinal fluke *Heterophyes heterophyes* from a Yemen bat, *Rhinolophus clivosus acrotis*. *Jour. Parasit.*, **39**, (5), p. 571.

MATTINGLY, P. F., and KNIGHT, K. L.

1956. The mosquitoes of Arabia. I. *Bull. Brit. Mus. Nat. Hist.*, **4**, (3), pp. 91-141.

MOUNT, R. A.

1953. Medical mission to the Yemen, southwest Arabia, 1951. I. Geomedical observations. *Amer. Jour. Trop. Med. Hyg.*, **2**, (1), pp. 1-12.

MOUNT, R. A., and BARANSKI, J. R.

1953. Medical mission to the Yemen, southwest Arabia, 1951. III. A serological and bacteriological survey. *Amer. Jour. Trop. Med. Hyg.*, **2**, (1), pp. 20-29.

NUTTALL, G. H. F., WARBURTON, C., COOPER, W. F., and ROBINSON, L. E.

1908. Ticks. A monograph of the Ixodoidea. Part 1. The Argasidae, pp. 1-104 and Bibliography (35 pp.). Cambridge University Press.

PATTON, W. S., and CRAGG, F. W.

1913. A textbook of medical entomology. 768 pp. London, Madras and Calcutta.

RADFORD, C. D.

1954. Some mites of Yemen collected by the medical mission of the United States Naval Medical Research Unit No. 3. *Fieldiana: Zool.*, **34**, (28), pp. 295-313.

ROBINSON, L. E.

1926. The genus *Amblyomma*, in NUTTALL, G. H. F., *et al.*, Ticks. A monograph of the Ixodoidea, 302 pp. Cambridge University Press.

SANBORN, C. C., and HOOGSTRAAL, H.

1953. Some mammals of Yemen and their ectoparasites. *Fieldiana: Zool.*, **34**, (23), pp. 229-252.

SCHMIDT, K. P.

1953. Amphibians and reptiles of Yemen. *Fieldiana: Zool.*, **34**, (24), pp. 253-261.

SCHULZE, P.

1936. Zwei neue *Rhipicephalus* und eine neue *Haemaphysalis* nebst Bemerkungen über Zeckenarten aus verschiedenen Gattungen. *Zeitschr. f. Parasitenk.*, **8**, Heft 5, pp. 521-527, 6 text figs.

SCOTT, H.

1942. In the high Yemen. 260 pp. London.

THEILER, G., WALKER, J. B., and WILEY, A. J.

1956. Ticks in the South African Zoological Survey collection: Part VIII: Two East African ticks. Onderstepoort Jour. vet. Res., 27, (1), pp. 83-99.

THEODOR, O.

1953. On a collection of *Phlebotomus* from the Yemen. Jour. Washington Acad. Sci., 43, (4), pp. 119-121.

THEODOR, O., and MOSCONA, A.

1954. On bat parasites in Palestine. I. Nycteribiidae, Streblidae, Hemiptera Siphonaptera. Parasitology, 44, (1-2), pp. 157-245.



Hoogstraal, Harry and Kaiser, Makram N. 1959. "Ticks (Ixodoidea) of Arabia, with special reference to the Yemen." *Fieldiana* 39, 297–322.

View This Item Online: <https://www.biodiversitylibrary.org/item/21492>

Permalink: <https://www.biodiversitylibrary.org/partpdf/16747>

Holding Institution

University Library, University of Illinois Urbana Champaign

Sponsored by

University of Illinois Urbana-Champaign

Copyright & Reuse

Copyright Status: In copyright. Digitized with the permission of the rights holder.

Rights Holder: Field Museum of Natural History

License: <http://creativecommons.org/licenses/by-nc-sa/3.0/>

Rights: <https://biodiversitylibrary.org/permissions>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.