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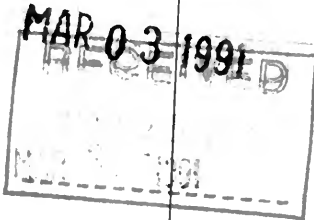
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FIELDIANA Zoology

Published by Field Museum of Natural History

New Series, No. 6

November 12, 1980

Ticks (Ixodoidea) from Wild Sheep and Goats in Iran and Medical and Veterinary Implications

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ABSTRACT

Ticks (508 specimens in 65 records from 19 localities in Iran) taken from *Ovis orientalis* subsp. and *Capra hircus aegagrus* were **Argasidae**: *Ornithodoros (Alveonasus) canestrinii*; and **Ixodidae**: *Ixodes (I.) ricinus*, *Haemaphysalis (Allophysalis) kopetdaghica*, *H. (Aboimimalis) punctata*, *H. (Herpetobia) kashmirensis*, *H. (H.) sulcata*, *H. (Segalia) parva*, *Hyalomma (Hyalommina) kumari*, *H. (Hyalomma) anatolicum excavatum*, *H. (H.) asiaticum caucasicum*, *H. (H.) marginatum marginatum*, *H. (H.) marginatum turanicum*, *Dermacentor (D.) niveus*, *D. (D.) raskemensis*, *Rhipicephalus (Digineus) bursa*, and *R. (R.) turanicus*. Many populations of wild sheep and goats in Iran live close to flocks of domestic sheep and goats and other domestic mammals. Habitats common to these ani-

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²From Research Project MR041.09.01-0152, Naval Medical Research and Development Command, National Naval Medical Center, Bethesda, Maryland. 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 Department of the Navy or of the naval service at large. This research was assisted by Agreement 03-036-N between the National Institute of Allergy and Infectious Diseases (National Institutes of Health) and NAMRU-3

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Submitted October 17, 1978; accepted for publication August 6, 1979

Library of Congress Catalog Card Number: 80-68334
ISSN 0015-0754

Publication 1312

FEB 25 1981

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mals provide frequent opportunities for exchanging ticks and tickborne infectious agents. Crimean-Congo hemorrhagic fever and Bhanja viruses (Bunyaviridae), already recorded from Iran, cause illness in humans and infect sheep and goats and several tick species listed above. Nairobi sheep disease virus (identical to Ganjam virus of India), an agent infecting sheep, goats, humans, and *Haemaphysalis* and *Rhipicephalus* ticks, should be searched for in Iran, as well as Wad Medani virus (Reoviridae), known from sheep, goats, cattle, and several tick species in southern USSR, India, Pakistan, and Sudan. Tickborne Q fever (*Coxiella burnetii*) is common, and tularemia (*Francisella tularensis*) and tick typhus (*Rickettsia siberica*) also occur in Iran. All the tick species taken from wild sheep and goats are candidates for investigation as vectors of organisms reported to infect domestic breeds in Iran and also likely to infect wild populations. These agents are *Babesia motasi*, *B. ovis*, *Theileria hirci* (= *T. ovis*), *Anaplasma ovis*, and *Eperythrozoon ovis*.

INTRODUCTION

In the rapidly changing environments of the world, resulting from exploitation by increasing numbers of humans and domestic animals, primitive patterns of tick-host-pathogen interrelationships are frequently modified by changed population densities of one or each of these three elements in the epidemiological processes of an infectious agent (Hoogstraal, 1973). Exchange of tick parasites between wild and domestic animals is common, and tick transmission of infectious agents between these animals, as well as tangentially to humans, is richly documented.

The extensive system of national parks and protected regions in Iran permits the survival of a number of game animals infested by tick species native to the habitat and by other tick species now established in these areas following introduction of domestic animals. To provide background data for epidemiological investigations of tickborne infections of humans and wild and domestic animals in Iran, we present data for one argasid and 15 ixodid tick species and subspecies taken from the Asian wild sheep (urial), *Ovis orientalis* subsp., and the wild goat, *Capra hircus aegagrus* Erxleben (table 1). These collections were made during systematic and ecological investigations sponsored by the Iran Department of the Environment (and earlier by the Game and Fish Department) and by the Street Expedition of Field Museum of Natural History (Lay, 1967).

The national parks and protected regions of Iran were described by Firouz (1974). Filippova et al. (1976) listed the principal publications on ticks of Iran and presented data for 642 ixodids taken from small-size wild mammals (chiefly rodents) in different ecological and zoogeographical zones of the country. The Neronov (1976) zoogeographical analysis of the rodent fauna of Iran, together with the Filippova et al. (1976) report, provide criteria useful for analyzing the distribution in Iran of some tick species recorded hereinafter.

Wild sheep and goats occur throughout Iran except in forests and other tall vegetation. Sheep prefer open, undulating environments; goats prefer rocky, precipitous terrain. Both inhabit many of the national parks and protected regions and occasionally graze close to each other, especially where undulating

and precipitous habitats meet. These localities are scattered in different climatic and physiographic zones. In the north, both animals inhabit high altitudes (over 3,000 m) of the Elburz (Alborz) mountains with high annual rainfall (600 mm) and cold winters. In the south, where habitat altitudes may be less than 1,000 m, annual rainfall is less than 200 mm, and winter temperatures rarely fall below freezing.

Most of Iran is open rangeland grazed principally by domestic sheep and goats. No domestic livestock is allowed within the national parks, but wild sheep and goats are free to leave the park confines and graze with domestic animals. Livestock are permitted to graze in all protected regions except Khosh Yeilagh and on Kabudan Island of the Lake Rezaiyeh Protected Region. These movements and the proximity of grazing ranges of wild sheep and goats and of other wild and domestic vertebrates permit interchange of tick parasites that may be infected by a variety of viruses, rickettsias, bacteria, piroplasms, and other agents infectious for these animals and for humans. The infectious agents that may be associated with ticks infecting wild sheep and goats in Iran are reviewed below.

Collecting localities are shown in Figure 1. Trans-Caspian urials (*Ovis orientalis arkal*) were taken in localities 1, 2, and 3; Armenian wild sheep (*O. o. gmelinii*), in localities 6, 8, and 9; hybrids of *O. o. arkal* × *O. o. gmelinii*, in localities 4 and 5; Laristan wild sheep (*O. o. laristanica*), in localities 11 and 15; and hybrids of *O. o. laristanica* × *O. o. blanfordi*, in locality 12 (Valdez et al., 1978). All wild goats were *Capra hircus aegagrus*. Few data have been published for ticks parasitizing these animals anywhere in Eurasia.

COLLECTING LOCALITIES, HOSTS, AND TICKS

1. Tandoureh Protected Region (37°30' N, 58°45' E), 2,000 m. **Ovis:** *Haemaphysalis sulcata*, *H. parva*.

2. Mohammad Reza Shah National Park (37°20' N, 56°07' E), 2,000 m. **Ovis:** *Haemaphysalis punctata*, *H. sulcata*, *Hyalomma m. marginatum*, *Dermacentor niveus*, *Rhipicephalus bursa*, *R. turanicus*. **Capra:** *Ixodes ricinus*, *Haemaphysalis punctata*, *H. sulcata*, *Hyalomma asiaticum caucasicum*, *H. m. marginatum*, *Rhipicephalus bursa*.

3. Khosh Yeilagh Protected Region (37°20' N, 55°29' E), 2,000 m. **Ovis:** *Haemaphysalis punctata*, *H. sulcata*, *Dermacentor raskemensis*, *Rhipicephalus bursa*, *R. turanicus*.

4. Parvar Protected Region (36°06' N, 53°35' E), 2,000 m. **Ovis:** *Haemaphysalis punctata*, *Rhipicephalus bursa*.

5. Imperial Reserve (35°41' N, 51°34' E), 1,500 m. **Ovis:** *Hyalomma asiaticum caucasicum*. 5A (not indicated in map, fig. 1). Gach Sar (36°07' N, 51°19' E), 2,400 m. **Capra:** *Haemaphysalis kopetdaghica*.

6. Marakan Protected Region (38°53' N, 45°11' E), 2,000 m. **Capra:** *Rhipicephalus bursa*.

7. Maku (39°17' N, 44°37' E) (near), 2,000 m. **Capra:** *Hyalomma kumari*.

8. Kabudan Island (37°28' N, 45°37' E). **Ovis:** *Haemaphysalis sulcata*, *Hyalomma marginatum turanicum*.



FIG. 1. Collecting localities of wild sheep and goats in Iran: 1, Tandoureh; 2, Mohammad Reza Shah National Park; 3, Khosh-Yeilagh Wildlife Refuge; 4, Parvar Wildlife Refuge; 5, Imperial Reserve; 6, Marakan Protected Area; 7, Maku; 8, Kabudan Island; 9, Bijar Protected Area; 10, Bisotoun Protected Region; 11, Bamou National Park; 12, Khabr-va-Rouchun Wildlife Refuge; 13, Ahram; 14, Jahrom; 15, Hormoud Wildlife Refuge; 16, Bastak; 17, Minab; 18, Iranshahr and Bampur.

9. Bijar Protected Region ($36^{\circ}06' N$, $47^{\circ}40' E$), 1,500 m. **Ovis:** *Haemaphysalis sulcata*, *Hyalomma anatolicum excavatum*.

10. Bisotoun Protected Region ($34^{\circ}25' N$, $47^{\circ}10' E$), 2,000 m. **Capra:** *Haemaphysalis sulcata*, *Dermacentor raskemensis*.

11. Bamou National Park ($29^{\circ}41' N$, $52^{\circ}45' E$), 1,500 m. **Ovis:** *Hyalomma asiaticum caucasicum*.

12. Khabr-va-Rouchoon Protected Region ($28^{\circ}45' N$, $56^{\circ}23' E$), 1,500 m. **Ovis:** *Hyalomma asiaticum caucasicum*.

13. Ahram ($28^{\circ}52' N$, $51^{\circ}16' E$) (near), 2,000 m. **Capra:** *Hyalomma asiaticum caucasicum*.

14. Jahrom ($28^{\circ}31' N$, $53^{\circ}33' E$) (near), 2,000 m. **Capra:** *Haemaphysalis kashmirensis*, *Hyalomma marginatum turanicum*.

15. Hormoud Wildlife Refuge ($27^{\circ}35' N$, $54^{\circ}05' E$), 1,500 m. **Ovis:** *Hyalomma asiaticum caucasicum*.

16. Bastak (27°16' N, 54°26' E) (near), 1,000 m. **Capra:** *Ornithodoros canestrinii*, *Haemaphysalis sulcata*, *Hyalomma asiaticum caucasicum*.

17. Minab (27°07' N, 57°06' E), 80 m. **Capra:** *Haemaphysalis sulcata*, *Hyalomma asiaticum caucasicum*.

18. Between Iranshahr (27°12' N, 60°27' E), 1,000 m and Bampur (27°13' N, 60°41' E), 1,000 m. **Ovis:** *Hyalomma marginatum turanicum*.

TICK SPECIES

The tick collecting data are listed in Table 1. The chief biological properties of most tick species taken from wild sheep and goats in Iran are reviewed in Hoogstraal (1979) and are only briefly summarized here. Some unpublished data in the Hoogstraal Tick Collection (HTC) are included.

Family Argasidae

Ornithodoros (Alveonasus) canestrinii (Birula, 1895) was originally described from Tehran and Tash-Burun, Iran; this very poorly known species is also recorded from caves sheltering domestic sheep and goats and from stables in Turkmenia, where the only biological studies have been undertaken (Kusov, 1973). The HTC contains other *O. (A.) canestrinii* collections from stables in Isfahan and Fars (ca. 180 km SE of Shiraz) in Iran, from sheep in Jerusalem, and from "Transcaucasia" in USSR. Wild sheep and goats are probably the chief host of each feeding stage; cattle and other domestic mammals are also parasitized. Larvae feed for 10-31 days, second to fifth nymphal instars and adults feed more rapidly (the first nymphal instar does not feed). In cold weather or where hosts rarely appear in the ticks' habitat, the life cycle may require 10-16 years to complete. Specimens that have not fed for 10 years have survived in the laboratory. This species appears to be able to tolerate extraordinarily low atmospheric humidity. Its saliva contains a toxin that causes the host skin to become swollen and bluish. Spirochetes have not been observed in *O. (A.) canestrinii*.

Family Ixodidae

Ixodes (Ixodes) ricinus (Linnaeus, 1758), a common three-host parasite in many European broadleaf and mixed forest areas, reaches the southeastern limit of its distribution in the humid forests of the Caspian area and northern mountain slopes in Iran. Often called the sheep tick, *I. (I.) ricinus* is a vector of numerous agents causing disease in humans and in wild and domestic vertebrates. Biologically and biomedically, *I. (I.) ricinus* is one of the world's best known tick species and is notorious for the wide range of vertebrates, often including humans, parasitized by each developmental stage. Few specimens were taken in the present survey, but the HTC contains much data for *I. (I.) ricinus* from other wild mammals and birds in Iran.

Haemaphysalis (Allophysalis) kopetdaghica Kerbabayev, 1962, was previously reported only from the type series, consisting of three males, one female, three nymphs, and three larvae from a leopard, wild goat, and domestic horse in highlands of the Kopet Dag Mountains, east of the Caspian Sea in Turkmen

TABLE 1. Ticks from *Ovis orientalis* subsp. and *Capra hircus aegagrus* from Iran.

Ticks				Host (No.)	Locality No. (Fig. 1)	Date	Collection No.
♂	♀	N	L				
FAMILY ARGASIDAE							
<i>Ornithodoros (Alveonasus) canestrinii</i> (Birula)							
0	0	0	14	Capra (1)	16	20 Nov 68	HH15,992
FAMILY IXODIDAE							
<i>Ixodes (Ixodes) ricinus</i> (Linnaeus)							
0	2	1	0	Capra (2)	2	Undated	HH27,423-4
<i>Haemaphysalis (Allophysalis) kopetdaghica</i> Kerbabayev							
48	69	59	29	Capra (1 immature)	5A	Spring 78	HH45,487
<i>Haemaphysalis (Aboimusalis) punctata</i> Canestrini & Fanzago							
2	0	0	0	Ovis (1)	2	20 Oct 68	HH9536
2	2	0	0	Ovis (1)	2	3 Oct 69	HH40,288
1	0	0	0	Capra (1)	2	Undated	HH43,087
4	2	0	0	Ovis (4)	3	7-10 Sep 69	HH40,282-4, 45,083
4	1	0	0	Ovis (1)	4	31 Dec 68	HH9554
<i>Haemaphysalis (Herpetobia) kashmirensis</i> Hoogstraal & Varma							
1	1	0	0	Capra (1)	14	11 Oct 68	HH41,777
<i>Haemaphysalis (Herpetobia) sulcata</i> Canestrini & Fanzago							
2	0	0	0	Ovis (1)	1	14 Nov 74	HH44,657
1	0	0	0	Ovis (1)	2	22 Oct 69	HH9534
0	6	0	0	Capra (1)	2	19 Oct 68	HH9535
0	1	0	0	Capra (1)	2	22 Oct 69	HH9533
1	0	0	0	Capra (1)	2	19 Jan 69	HH9547
1	0	0	0	Ovis (1)	3	26 Mar 74	HH44,659
18	11	0	0	Capra (1 immature)	5A	Spring 78	HH45,480
1	0	0	0	Ovis (1)	8	30 Aug 69	HH40,278
14	5	0	0	Ovis (2)	8	29-30 Sep 69	HH40,285-6
7	9	0	0	Ovis (1)	8	Aug 71	HH43,088
0	4	0	0	Ovis (1)	8	10 May 75	HH44,703
1	0	0	0	Ovis (1)	9	13 Sep 74	HH44,704
0	1	0	0	Capra (1)	10	19 Mar 60	HH6386
0	2	0	0	Capra (1)	16	20 Nov 68	HH41,762
1	1	0	0	Capra (1)	17	1 Dec 68	HH41,760
<i>Haemaphysalis (Seqalia) parva</i> (Neumann)							
4	0	0	0	Ovis (1)	7	14 Nov 74	HH44,658
<i>Hyalomma (Hyalomma) kumari</i> Sharif							
0	4	0	0	Capra (1)	7	28 Jul 68	HH54,114
<i>Hyalomma (Hyalomma) anatolicum excavatum</i> Koch							
5	0	0	0	Ovis (1)	9	13 Sep 74	HH57,887
<i>Hyalomma (Hyalomma) asiaticum caucasicum</i> Pomerantsev & Matikashvili							
0	1	0	0	Capra (1)	2	16 Jun 69	HH53,296
2	1	0	0	Ovis (1)	5	28 Aug 69	HH53,297
1	1	0	0	Ovis (1)	11	4 Nov 74	HH57,760
15	14	0	0	Ovis (2)	15	10 Jan 75	HH57,761-2
2	1	0	0	Ovis (1)	12	13 Jan 75	HH57,759
9	5	0	0	Capra (1)	13	11 Nov 68	HH54,071
2	2	0	0	Capra (1)	16	20 Nov 68	HH54,068
1	1	0	0	Capra (1)	17	1 Dec 68	HH54,062
<i>Hyalomma (Hyalomma) marginatum marginatum</i> Koch							
0	1	0	0	Capra (1)	2	16 Oct 68	HH51,071
1	0	0	0	Ovis (1)	2	3 Sep 69	HH53,295

TABLE 1. Continued.

Ticks				Host (No.)	Locality No. (Fig. 1)	Date	Collection No.
♂	♀	N	L				
FAMILY IXODIDAE							
<i>Hyalomma (Hyalomma) marginatum turanicum</i> Pomerantsev							
1	0	0	0	<i>Ovis</i> (1)	8	2 Aug 68	HH54,116
1	0	0	0	<i>Capra</i> (1)	14	11 Nov 68	HH54,072
2	0	0	0	<i>Ovis</i> (1)	18	2 Dec 62	HH4186
<i>Dermacentor (Dermacentor) niveus</i> Neumann							
1	0	0	0	<i>Ovis</i> (1)	2	18 Oct 69	HH79,031
<i>Dermacentor (Dermacentor) raskemensis</i> Pomerantsev							
0	1	0	0	<i>Ovis</i> (1)	3	3 Sep 69	HH77,614
6	3	0	0	<i>Ovis</i> (2)	3	26 Mar 74	HH79,449-450
2	1	0	0	<i>Capra</i> (1 immature)	5A	Spring 78	HH79,526
2	1	0	0	<i>Capra</i> (1)	10	13 Apr 60	HH32,042
<i>Rhipicephalus (Digineus) bursa</i> Canestrini & Fanzago							
4	1	0	0	<i>Ovis</i> (1)	2	19 Jan 69	HH81,326
22	12	2	0	<i>Ovis</i> (5)	2	Undated	HH82,154-9
12	6	0	0	<i>Capra</i> (2)	2	Undated	HH82,160-1
13	1	0	0	<i>Capra</i> (1)	2	5 Sep 63	HH83,444
0	3	0	0	<i>Ovis</i> (1)	3	26 Mar 74	HH83,277
0	1	0	0	<i>Ovis</i> (1)	4	10 Sep 69	HH83,434
0	0	2	0	<i>Capra</i> (1)	6	13 Dec 71	HH82,163
<i>Rhipicephalus (Rhipicephalus) turanicus</i> Pomerantsev							
1	4	0	0	<i>Ovis</i> (2)	2	Undated	HH82,155-7
0	1	0	0	<i>Ovis</i> (1)	3	26 Mar 74	HH83,635
TOTAL TICKS: 218 ♂, 183 ♀, 64 N, 43 L							

SSR. The 205 specimens recorded herein from an immature (probably sick) wild goat in the Elburz Mountains, south of the Caspian sea in Manzadaran Province (ca. 50 km NNW of Tehran), permitted validation of this previously uncertain taxon (Hoogstraal & Wassef, 1979). Among the 150 species comprising the genus *Haemaphysalis*, *H. (A.) kopetdaghica* is one of the few whose immatures and adults feed together on large-sized herbivores. The life cycle of all *Haemaphysalis* species, where known, is of the three-host type (Hoogstraal, 1978). It would be interesting to determine whether *H. (A.) kopetdaghica* conforms to the usual three-host pattern. Wild goats are probably the chief host of this species.

Haemaphysalis (Aboimialis) punctata Canestrini & Fanzago, 1878, has approximately the same geographical range as *I. (I.) ricinus* but occurs in more open forest, shrub, and pasture environments. Immatures feed, chiefly in summer, on a wide variety of birds and also on hares, less often on reptiles and other mammals. Adults parasitize domestic and larger-sized wild mammals, occasionally hares, ground squirrels, and ground-feeding birds. Adults are active mostly in spring or fall. The life cycle often requires two years but may be completed in one year in warm habitats.

Haemaphysalis (Herpetobia) kashmirensis Hoogstraal & Varma, 1962, is represented in the HTC by numerous records from localities between 1,500 and 3,000 m altitude in northwestern India, northern Pakistan, and Afghanistan. The

single Iranian record from *Capra* "west of Jahrom" extends the known distribution far southwest of all others. Adult *H. (H.) kashmirensis* typically infest wild and domestic sheep and goats, immature stages parasitize *Agama* lizards and occasionally rodents (Hoogstraal & McCarthy, 1965). The HTC data show feeding of adults in spring and fall, nymphs from spring through fall, and larvae during summer.

Haemaphysalis (Herpetobia) sulcata (Canestrini & Fanzago, 1878) adults comprised 15 of the 65 tick records from 9 of the 19 collecting localities (table 1). This species is distributed from India (Kashmir), southern USSR, and southwestern Asia to the western Mediterranean area. Adults thrive on wild and domestic sheep and goats and also on cattle, horses, and camels in a variety of lowland and mountainous semideserts and steppes (Grebenyuk, 1966). Reptiles and birds are the chief hosts of immatures, which also feed on rodents. Adults feed chiefly from March through May and in October and November or, in certain environments, throughout the winter or throughout the year. Immatures feed from April through September, but chiefly from May to July, with higher larval numbers earlier and higher nymphal numbers later in the season.

Haemaphysalis (Segalia) parva (Neumann, 1897) is known from Iran only by the single collection from *Ovis* and six collections from foxes (HTC), all from near the Turkish and Soviet borders. Westward, the range of this species extends to Italy and also to parts of Libya. Sheep, goats, and other Artiodactyla, and also Carnivora, are hosts of adults. Immatures parasitize rodents, reptiles, birds, and insectivores.

Hyalomma (Hyalomma) kumari Sharif, 1928, from the Maku area near the Turkish-Soviet frontier, is an Indian parasite of domestic and wild goats and sheep (Kaiser & Hoogstraal, 1964). Immature stages parasitize rodents and birds. The Maku data extend the known range of this species several hundred kilometers west of all previous records (eastern Afghanistan) (Kaiser & Hoogstraal, 1963). Other samples in the HTC are from Nepal and Pakistan. The single Soviet record is from the Tadzhik markhor, *Capra falconeri heptneri* Zalkin (sic), at 1,200 m altitude on Mt. Darvaza, Tadzhik SSR (Starkov, 1972).

Hyalomma (Hyalomma) anatolicum excavatum Koch, 1844, and the subspecies *anatolicum* Koch, 1844, both commonly parasitize cattle, camels, and horses from Central Asia to the Mediterranean area and some distance into Africa. Sheep and goats are also infested. The subspecies *anatolicum* is locally abundant on domestic mammals in certain areas of Iran (Abassian-Lintzen, 1961), but the subspecies *excavatum* appears to be uncommon. The biology of the *anatolicum* complex is reviewed by Hoogstraal (1979).

Hyalomma (Hyalomma) asiaticum caucasicum Pomerantsev & Matikashvily, 1940, the westernmost representative of the southern Palearctic *H. asiaticum* complex of four subspecies, is listed from eight of the 19 Iranian collecting localities (table 1). Samples from some localities do not conform precisely to Soviet criteria for identifying this and other subspecies or to samples from the USSR presented to the HTC by Soviet colleagues. Study of numerous carefully documented samples from throughout the wide range of *H. asiaticum* is necessary to resolve questions relating to subspecies biology and identity. Six of the eight Iranian collections were taken in winter (November-January). *Hyalomma asiaticum* adults parasitize camels and other domestic herbivores and also wild goats and sheep, pigs, and gazelles in semidesert and desert environments.

Immatures infest burrowing mammals, especially rodents, and also hedgehogs, hares, and carnivores preying on rodents.

Hyalomma (Hyalomma) marginatum Koch, 1844, ranges from southern Europe to the Caspian, with outlying pockets in the mountains of the Mohammad Reza Shah National Park. Adults feed chiefly on domestic and wild ungulates; immatures infest hares, hedgehogs, or ground-feeding birds. Many southward migrating birds are infested by the combined larval-nymphal stages of this two-host tick. The numerous biological studies of the subspecies *marginatum* and *turanicum* are reviewed by Hoogstraal (1979).

Hyalomma (Hyalomma) marginatum turanicum Pomerantsev, 1946, occurs in the Palearctic Region chiefly south of the range of the nominate subspecies, eastward to India, and also in scattered areas of northeastern Africa. Biologically, the subspecies *marginatum* and *turanicum* are quite similar, and epidemiologically they are also associated with the same or closely related agents causing diseases in humans and lower animals.

Dermacentor (Dermacentor) niveus Neumann, 1897, was defined by Olenev (1927a, b) but has been confused in much literature. This tick is erratically distributed in semidesert and steppe zones from the western Mediterranean area to southern USSR, Iran, and Afghanistan. Adults parasitize all kinds of domestic herbivores, often camels, and wild sheep, goats, deer, pigs, and wolves. Immatures feed on rodents, hedgehogs, and hares. In addition to the single collection from *Ovis* in the Mohammad Reza Shah Wildlife Park, we have two Iranian lots from humans, one from this park and one from the Parvar Protected Region, and other material, almost a century old, from "Cherestanak Tehran." A revisional study of specimen material and published data pertaining to *D. (D.) niveus* is needed.

Dermacentor (Dermacentor) raskemensis Serdyukova (in Pomerantsev), 1948, adults were redescribed by Dhanda et al. (1971) from materials from localities between 600 and 4,000 m altitude in India, Pakistan, and Afghanistan. The type locality is the Raskem region of Turkmenia. Domestic and wild sheep and goats appear to be the chief hosts of adults, which also parasitize foxes, yaks, and humans. The HTC contains adults from wild sheep and goats in Bamian Province, Afghanistan, adults from humans near Quetta, Pakistan, immatures from rodents (*Calomyscus*) and pikas (*Ochotona*) near Quetta, and adults and immatures from domestic goats in Himachal Pradesh, India. In addition to the four collections from wild sheep and goats in Iran (table 1), we have one male from a pika nest in Mazandaran, two males from the body of a human in Lorestan, and one male from a fox in Azerbaijan. Collection dates provided for five Iranian lots are all for spring, fall, or winter.

Rhipicephalus (Digineus) bursa Canestrini & Fanzago, 1878, is known in Iran only from northern localities; it ranges from the western Mediterranean (Portugal, Morocco, Algeria) to Kazakhstan and is especially numerous in and near western Turkey, Bulgaria, and southwestern USSR. Favorite habitats are grassy and lightly forested low- and medium-altitude mountain slopes and certain modified steppe and semidesert environments. The immatures and adults of this two-host tick feed on the same type of host, chiefly domestic and wild ungulates, sometimes on humans and hares. Wild ungulates are the original hosts. The seasonal dynamics differ in various habitats throughout the extensive range of *R. (D.) bursa*.

Rhipicephalus (Rhipicephalus) turanicus Pomerantsev & Matikashvily, 1940, is quite common and widely distributed in Iran on domestic ungulates and on wild carnivores and hares, but only two wild sheep hosts from northeastern areas are recorded. *Rhipicephalus (R.) turanicus* is widely distributed through the southern Palearctic Region (southern Europe and northern Africa) to India and China. Immature stages feed chiefly on rodents. The dynamics of this three-host species differ considerably in different habitats. The Soviet literature on hosts and biology was reviewed by Grebenyuk (1966) together with his own observations in Kirgizia.

DISEASE RELATIONSHIPS

The close proximity of many Iranian populations of wild sheep and goats to flocks of domestic sheep and goats and other domestic mammals presents frequent opportunities for exchanging ticks and tickborne infectious agents. Some of these agents may be further spread by other tick species feeding simultaneously on the same host and surviving transstadially or transovarially in the ticks to infect a new host and new tick generations, or they may be disseminated by inhalation, contact with infected animals, or crushing infected ticks on the skin.

This section is a brief review of certain infectious agents known to be associated with the tick species listed in Table 1; others of apparently less epidemiological importance are not mentioned. Agents that are prime candidates for investigation in relation to these species and to sheep, goats, and humans in Iran are also listed.

Crimean-Congo hemorrhagic fever (CCHF) virus.—CCHF virus (Bunyaviridae) circulates between at least 27 tick species and numerous wild and domestic mammals in Asia, Europe, and Africa. This agent has caused several epidemics, taking a serious toll of human life (Hoogstraal, 1979). Sheep and sheep-parasitizing ticks figure prominently among the vertebrate reservoirs and vectors of this virus.

Chumakov et al. (1970) detected antibodies to CCHF virus in agar gel diffusion and precipitation (AGDP) tests of 45 of 100 sheep sera from the Tehran abattoir. In 1970-1971, ca. 45% of Iranian domestic sheep and goat sera tested showed antibodies to CCHF virus; among sheep, 62% from northern areas and 28% from northeastern areas (avg. 54%) were positive (Saidi, 1974). In hemagglutination-inhibition (HI) tests, antibodies to the virus were detected in sera of 4 of 100 preschool children from the Caspian Sea area. Saidi et al. (1975), using the most recent and sophisticated serological techniques, detected antibodies to CCHF virus in 48 (13%) of 351 human sera from localities near the Caspian Sea and in East Azerbaijan Province, in 280 (38%) of 728 sheep sera (mostly from near the Caspian), and in 48 (36%) of 135 goat sera and 23 (18%) of 130 cattle sera from northern and central Iran. Sera from several rodent and bat species also reacted positively in these tests.

There have been no reports of attempts to isolate CCHF virus from ticks in Iran. However, six of the ticks listed in Table 1 have been implicated in CCHF virus epidemiology. These are: *Ixodes (I.) ricinus* in Moldavian SSR, Ukrainian SSR, and Bulgaria; *Haemaphysalis (A.) punctata* in Moldavian SSR and Ukrainian SSR; *Hyalomma (H.) marginatum marginatum* in RSFSR, Ukrainian SSR,

Kalmyk ASSR, Armenian SSR, Azerbaijan SSR, Bulgaria, and Yugoslavia; *H. (H.) marginatum turanicum* in Uzbek SSR, Kirgiz SSR, and Tadzhik SSR; *Rhipicephalus (D.) bursa* in Ukrainian SSR, Armenian SSR, Turkmen SSR, and Bulgaria; and *R. (R.) turanicus* in Uzbek SSR.

Bhanja (BHA) virus.—BHA virus (Bunyaviridae) has been isolated from nine tick species commonly infesting wild and domestic mammals in several states of India and southern republics of the Soviet Union (faunistically and ecologically similar to large areas of Iran) and in southern Europe and northern Africa (Cameroun, Central African Republic, Nigeria, Senegal).

Domestic sheep are common reservoirs of the virus. A "small proportion" of 3,000 sera from humans and domestic and wild mammals from various localities in Iran showed antibodies to BHA virus (Saidi, 1975). Arata (1975) mentioned the presence of BHA virus in Iran and listed this as a "representative rodent-born (sic) disease." However, the only BHA isolates reported from small mammals are from a hedgehog and a ground squirrel in Nigeria (Kemp et al., 1974).

The original BHA isolate was from a *Haemaphysalis* tick from a paralyzed goat in Orissa, India (Shah & Work, 1969). The human illness caused by a laboratory-acquired infection of BHA virus (isolate from *Haemaphysalis [A.] punctata* from Yugoslavia) was described by Calisher & Goodpasture (1975). The BHA strains from tick species listed in Table 1 have been from *Hyalomma (H.) marginatum turanicum* from sheep in Kirgiz SSR (Karas' et al., 1974), *Rhipicephalus (D.) bursa* in Azerbaijan SSR (L'vov et al., 1975), and *Haemaphysalis (A.) punctata* in Yugoslavia (Vesenjak-Hirjan et al., 1977) and Italy (Saccà et al., 1969; Verani et al., 1969, 1970a, b). BHA virus has been isolated from sheep in Nigeria (Kemp et al., 1971, 1973) and from a variety of tick species taken from sheep, goats, and cattle throughout the known range of this agent. Antibodies to BHA virus have been detected in sera of humans and sheep, goats, and cattle from India (Shah & Work, 1969; Shanmugan et al., 1974), Iran (Saidi, 1975), Armenian SSR (Matevosyan et al., 1974a, b), Italy (Lopes et al., 1970; Verani et al., 1970a, 1971; Albanese et al., 1971; Castro et al., 1976), and Nigeria (Causey et al., 1968).

Nairobi sheep disease (NSD) virus.—NSD virus (Bunyaviridae) is a prime candidate for investigation in Iran. This virus, which often causes severe mortality in domestic sheep infested by *Rhipicephalus appendicalatus* in eastern Africa, is identical to Ganjam (GAN) virus of India (Casals, 1975; Hoogstraal, 1980) where it has been isolated from *Haemaphysalis* ticks from sheep and goats and associated with acutely febrile human illness (Dandawate & Shah, 1969; Dandawate et al., 1969; Boshell et al., 1970; Rajagopalan et al., 1970). Dugbe (DUG) virus, another African member of the NSD serogroup, also causes febrile illness in infected humans (Moore et al., 1975).

Wad Medani (WM) virus.—WM virus (Reoviridae) has been isolated from *Rhipicephalus (R.) turanicus* and *Hyalomma (H.) a. asiaticum* from sheep in Turkmenia (Skvortsova et al., 1975). WM virus also infects *Hyalomma*, *Amblyomma*, *Boophilus*, and *Rhipicephalus* ticks parasitizing sheep, goats, and cattle in other Soviet Republics and in India, Pakistan, Egypt, Sudan, and Senegal. This virus probably occurs in Iran.

Batken (BKN) virus.—BKN virus (unclassified) was isolated from adult *Hyalomma (H.) marginatum marginatum* from sheep in Osh Oblast, Kirgiz SSR. Complement-fixation antibodies were detected in sera from two of 579 humans, two of 200 sheep, and two of 150 cattle from the Lenin region of this republic

(L'vov et al., 1974; Berge, 1975). This virus is a candidate for investigation in Iranian sheep and goats.

Dhori (DHO) virus.—DHO virus (Bunyaviridae) has been isolated from several *Hyalomma* and *Dermacentor* species infesting domestic animals from India through southern USSR to Egypt and Portugal. Among these, DHO virus was reported from a *Dermacentor* species from sheep and from *Hyalomma (H.) marginatum marginatum* in the mountain steppes of Armenian SSR and Azerbaijan SSR (Semashko et al., 1974, 1975). This virus is likely to infect sheep and goats in Iran.

Rickettsia siberica.—*Rickettsia siberica* is a member of the Rocky Mountain spotted fever (*R. rickettsi*) (RSSE) complex and the agent of Siberian tick typhus (Lyskovtsev, 1963; Hoogstraal, 1967). This rickettsia infects at least nine tick species. *Haemaphysalis (A.) punctata* is an important vector (together with *Dermacentor marginatus*) in foothills and valleys of Kirgiz SSR, where its bionomics have been studied by Grebenyuk (1955) and Sartbaev (1961). In the same republic, *Hyalomma (H.) asiaticum* is also a vector (Proreshnaya & Rapoport, 1963). All tick species infesting wild sheep and goats are candidates for investigation as reservoirs and vectors of *R. siberica*. From results of studying 876 rodent sera from 47 Iranian localities, Hamidi et al. (1974) concluded that *R. siberica* is "probably distributed throughout most parts of Iran."

Coxiella burnetii.—The rickettsial agent of Q fever is likely to infect most tick species parasitizing wild and domestic sheep and goats. Q fever is a widely distributed zoonotic disease of humans in Iran (Giroud & Yassemi, 1952; Rafyi & Maghami, 1954; Gajdusek & Bahmanyar 1955; Faghih et al., 1955; Hekmat, 1964; Eghtedari et al., 1970; Caughey et al., 1971; Saadatezadeh et al., 1973; Hamidi et al., 1974). This organism frequently causes illness in persons having contact with infected sheep, goats, and cattle.

Francisella tularensis.—The bacterial agent causing tularemia appears, from present scanty evidence, to be quite restricted in distribution in Iran; its association with ticks has not been investigated in this country. After having failed to isolate the organism from numerous small animals trapped in 47 localities in 1969 and 1970, Neronov (1974) and colleagues studied serum samples from 100 cattle and 100 sheep from the Tehran abattoir and from 39 wild mammals. Samples from eight sheep, three cattle, and one hedgehog, *Hemiechimus megalotis*, from near Zabul in the Helmund River valley reacted positively for tularemia infections. Neronov also quoted unpublished results (data not specified) of the Institute Pasteur Tehran indicating human infections in this country.

Diseases of sheep and goats.—All the tick species listed in Table 1 are candidates for investigation as vectors of organisms infecting both domestic and wild sheep and goats in Iran. The agents reported from domestic breeds in Iran are (**Protozoa**): *Babesia motasi*, *B. ovis*, and *Theileria hirci*; and (**Rickettsiales**): *Anaplasma ovis* and *Eperythrozoon ovis* (Delpy, 1936; Anwar et al., 1971). Malignant theileriosis caused by *T. hirci* (= *T. ovis*) has resulted in enormous losses among domestic sheep and goats chiefly in southern and southeastern areas of Iran (Rafyi & Maghami, 1966) where the usually cited vector, *Rhipicephalus (D.) bursa*, does not occur and *Hyalomma* spp. are the probable vectors (Mazlum, 1970).

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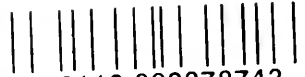
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