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The Ticks or Ixodides of the U.S.S.R.: A Review of the Literature

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THE TICKS, OR IXODIDES, OF THE U. S. S. R.

— A REVIEW OF THE LITERATURE —

by

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A Contribution of The Institute of Acarology.
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Introduction

This work is an attempt to bring together into one volume and into the English language the available information on the ticks occurring in the Union of Soviet Socialistic Republics. In cases where species of ticks are not endemic to Russia, information about the occurrence in other countries is included. However, this extralimital coverage is incomplete and in no way represents a thorough analysis of the tick fauna of these countries. The information included in this work is taken entirely from the extensive literature available and though many papers were translated it was impossible to translate them all in the time allotted. The abstracts of Russian articles appearing in the Review of Applied Entomology were of great value. Over one thousand references were available dealing with Russian ticks and approximately one-half of these were seen, either in the original or in the abstract form.

Under each species is presented information concerning the synonymy, the geographical distribution and host distribution, the hosts of the various stages, the seasonal activity, the habitat, the life cycle, the habits, the control measures against the tick species, the parasites of the ticks and the relation to human and animal diseases.

The most comprehensive work to date on the ticks of the U.S.S.R. was published in the Russian language by B. I. Pomerantzev in 1950. This work which deals only with the Family Ixodidae was started by Pomerantzev but due to his untimely death was completed by his associates.

Though the species listed as occurring in the U. S. S. R. by Pomerantzev have been accepted for the most part, some changes have been made to bring this work into line with the concepts of tick nomenclature held by American and other European workers. The arrangement, for example, of the genus Hyalomma is that of Delpy and that for the genus Rhipicephalus is essentially that of Zumpt. Other minor changes made are cited in the synonymy under each species.

The scientific names of the animals in the host lists in this work were checked by Dr. Herbert Friedman, Birds, and Dr. David H. Johnson, Mammals. This aid by these specialists in the U. S. National Museum is gratefully acknowledged.

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Geographical Distribution

Faunal List of the U. S. S. R.

Armenian S. S. R.

Dermacentor antrorum, D. marginatus, D. niveus, D. silvarum, Haemaphysalis inermis, H. otophila, H. numidiana taurica, H. punctata, H. sulcata, Hyalomma aegyptium, H. detritum, H. dromerdarii, H. excavatum, H. savignyi, Ixodes laguri armeniacus, I. ricinus, I. vespertilionis, Rhipicephalus bursa, R. rossicus, R. sanguineus.

Argas persicus, Ornithodoros lahorensis.

Azerbaijan S. S. R.

Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. silvarum, Haemaphysalis concinna, H. inermis, H. otophila, H. punctata, H. sulcata, H. warburtoni, Hyalomma aegyptium, H. detritum, H. dromedarii, H. savignyi, Ixodes crenulatus, I. laguri laguri, I. redikorzevi redikorzevi, I. redikorzevi emberizae, I. ricinus, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

Ornithodoros canestrinii, O. lahorensis, O. tholozani, O. verrucosus.

Byelorussian S. S. R.

Dermacentor marginatus, D. pictus, D. silvarum, Ixodes ricinus.

Estonian S. S. R.

Ixodes ricinus.

Georgian S. S. R.

Boophilus calcaratus, Haemaphysalis concinna, H. inermis, H. otophila, H. punctata, H. sulcata, H. warburtoni, Hyalomma aegyptium, H. detritum, H. savignyi, Ixodes crenulatus, I. frontalis, I. redikorzevi redikorzevi, I. ricinus, I. trianguliceps, Rhipicephalus bursa, R. rossicus, R. sanguineus.

Ornithodoros verrucosus.

Karelo-Finnish S. S. R.

Ixodes apronophorus, I. persulcatus, I. ricinus, I. trianguliceps.

Kazakh S. S. R.

Dermacentor marginatus, D. niveus, D. pavlovskyi, D. pictus, D. silvarum, Haemaphysalis concinna, H. numidiana turanica, H. punctata, H. sulcata, Hyalomma aegyptium, H. detritum, H. dromedarii, H. excavatum, H. rufipes, H. savignyi, Ixodes apronophorus, I. autumnalis, I. kazakstani, I. laguri laguri, I. persulcatus, I. plumbeus, I. ricinus, I. semenovi, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

Argas persicus, A. vespertilionis, Ornithodoros lahorensis, O. tartakovskyi, O. tholozani, O. verrucosus.

Kirghiz S. S. R.

Boophilus calcaratus, Dermacentor marginatus, D. pavlovskyi, D. pictus, Haemaphysalis caucasica, H. concinna, H. numidiana turanica, H. punctata, H. warburtoni, Hyalomma dromedarii, H. savignyi, Ixodes crenulatus, I. kazakstani, I. persulcatus, Rhipicephalus schulzei.

Ornithodoros lahorensis, O. tholozani.

Latvian S. S. R.

Ixodes ricinus.

Lithuanian S. S. R.

Ixodes ricinus.

Moldavian S. S. R.

Dermacentor niveus, Haemaphysalis inermis, H. punctata, Ixodes autumnalis, I. crenulatus, I. ricinus.

R. S. F. S. R.

Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. nuttalli, D. pictus, D. pomerantzevi, D. silvarum, D. variegatus

kamtschadalus, Haemaphysalis concinna, H. inermis, H. numidiana turanica, H. punctata, H. warburtoni, Hyalomma detritum, H. dromedarii, H. excavatum, H. rufipes, H. savignyi, Ixodes apronophorus, I. autumnalis, I. berlesei, I. canisuga, I. crenulatus, I. frontalis, I. laguri laguri, I. persulcatus, I. redikorzevi redikorzevi, I. ricinus, I. triangulicepsi, I. uriae, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

Argas persicus, A. reflexus, A. vespertilionis, Ornithodoros lahorensis, O. tartakovskyi.

Tadzhik S. S. R.

Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. silvarum, Haemaphysalis caucasica, H. numidiana turanica, H. pavlovskyi, H. punctata, H. sulcata, Hyalomma aegyptium, H. detritum, H. dromedarii, H. excavatum, H. rufipes, H. savignyi, Ixodes berlesei, I. crenulatus, I. redikorzevi redikorzevi, I. redikorzevi emberizae, I. ricinus, Rhipicephalus sanguineus, R. schulzei.

Argas reflexus, Ornithodoros lahorensis, O. tartakovskyi, O. tholozani.

Turkmen S. S. R.

Boophilus calcaratus, Dermacentor niveus, Haemaphysalis otophila, H. numidiana turanica, Hyalomma aegyptium, H. detritum, H. dromedarii, H. excavatum, Ixodes occultus, I. vespertilionis, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

Argas persicus, Ornithodoros cholodkovskyi, O. lahorensis, O. nereensis, O. tartakovskyi, O. tholozani.

Ukrainian S. S. R.

Boophilus calcaratus, Dermacentor marginatus, D. silvarum, Haemaphysalis caucasica, H. otophila, H. punctata, Hyalomma detritum, H. savignyi, Ixodes autumnalis, I. crenulatus, I. laguri laguri, I. ricinus, I. triangulicepsi, I. vespertilionis, Rhipicephalus bursa, R. rossicus, R. sanguineus.

Argas reflexus.

Uzbek S. S. R.

Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. pavlovskyi, Haemaphysalis concinna, H. numidiana turanica, H. punc-

tata, H. sulcata, Hyalomma aegyptium, H. detritum, H. dromedarii, H. excavatum, H. savignyi, Rhipicephalus sanguineus, R. schulzei.
Argas persicus, A. reflexus, Ornithodoros cholodkovskyi, O. lahorensis, O. tartakovskyi, O. tholozani.

Abkhazskaya A. S. S. R.

Dermacentor marginatus, Haemaphysalis concinna, H. inermis, H. punctata, Hyalomma savignyi, Ixodes ricinus, Rhipicephalus bursa, R. sanguineus.

Adzharskaya A. S. S. R.

Boophilus calcaratus, Ixodes ricinus.

Bashkirskaya A. S. S. R.

Dermacentor marginatus, D. silvarum, Ixodes birulai, I. persulcatus.

Buryat-Mongol A. S. S. R.

Dermacentor nuttalli.

Chuvash A. S. S. R.

Ixodes ricinus.

Crimean A. S. S. R.

Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. pictus, D. silvarum, Haemaphysalis caucasica, H. concinna, H. inermis, H. otophila, H. numidiana taurica, H. punctata, H. sulcata, Hyalomma aegyptium, H. detritum, H. savignyi, Ixodes crenulatus, I. frontalis, I. redikorzevi redikorzevi, I. ricinus, I. vespertilionis, Rhipicephalus bursa, R. rossicus, R. sanguineus.
Argas persicus, A. reflexus, A. vespertilionis.

Daghestan A. S. S. R.

Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. silvarum, Haemaphysalis caucasica, H. concinna, H. inermis, H. oto-

phila, H. numidiana taurica, H. punctata, H. sulcata, Hyalomma detritum, H. excavatum, H. savignyi, Ixodes laguri laguri, I. ricinus, Rhipicephalus bursa, R. rossicus, R. sanguineus.
Ornithodoros tholozani.

German-Volga A. S. S. R.

Hyalomma detritum, Rhipicephalus schulzei.

Kabardinskaya A. S. S. R.

Hyalomma savignyi.

Kalmuk A. S. S. R.

Haemaphysalis punctata.

Kara-Kalpakskaya A. S. S. R.

Dermacentor niveus, Hyalomma detritum, H. dromedarii.
Ornithodoros tholozani.

Komi A. S. S. R.

Ixodes triangulicepe.

Nakhichevanskaya A. S. S. R.

Haemaphysalis otophila, Hyalomma dromedarii, Rhipicephalus sanguineus.

Tatarskaya A. S. S. R.

Dermacentor silvarum, Ixodes persulcatus.

Yakutskaya, A. S. S. R.

Dermacentor silvarum.

Khakassays Autonomous Province

Dermacentor nuttalli.

Birobidzhan Autonomous Region

Dermacentor silvarum, Haemaphysalis concinna.

Altai Territory

Dermacentor pictus, D. silvarum, Ixodes autumnalis, I. persulcatus, I. ricinus.

Khabarovsk Territory

Dermacentor silvarum, Haemaphysalis concinna, Ixodes autumnalis, I. ovatus, I. persulcatus, I. ricinus.

Krasnodar Territory

Haemaphysalis concinna, H. inermis, Hyalomma aegyptium, H. detritum, H. savignyi.

Krasnoyarsk Territory

Dermacentor nuttalli, D. pictus, Haemaphysalis concinna. Ixodes persulcatus, I. ricinus, I. triangulicеps.
Argas reflexus.

Northern Territory

Ixodes persulcatus.

Primor Territory (Maritime)

Dermacentor pictus, D. silvarum, Haemaphysalis bispinosa, H. concinna, H. japonica var. douglasi, Ixodes pavlovskyi, I. persulcatus, I. pomerantzevi, I. ricinus, I. signatus.

Stavropol Territory

Boophilus calcaratus, Dermacentor marginatus, D. pictus, D. silvarum, Haemaphysalis concinna, H. otophila, H. punctata, Hyalomma detritum.
Argas persicus, Ornithodoros verrucosus.

Western Territory

Dermacentor pictus, Haemaphysalis punctata, Ixodes persulcatus, I. ricinus.

Caucasia

Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. pictus, D. silvarum, Haemaphysalis concinna, H. inermis, H. otophila, H. numidiana taurica, H. punctata, H. sulcata, Hyalomma aegyptium, H. detritum, H. dromedarii, H. excavatum, H. savignyi, Ixodes laguri colchicus, I. ovatus, I. ricinus, I. trianguliceps, Rhipicephalus bursa, R. rossicus, R. sanguineus.

Argas persicus, A. reflexus, A. vespertilionis, Ornithodoros canestrinii, O. tholozani, O. verrucosus.

Central Asia

Boophilus calcaratus, Dermacentor niveus, D. pavlovskyi, Haemaphysalis numidiana turanica, H. punctata, H. sulcata, Hyalomma aegyptium, H. detritum, H. dromedarii, H. excavatum, H. savignyi, Ixodes ricinus, Rhipicephalus bursa, R. sanguineus, R. schulzei.

Argas persicus, A. reflexus, A. vespertilionis, Ornithodoros cholodkovskyi, O. lahorensis, O. tartakovskyi, O. tholozani.

Ciscaucasia

Haemaphysalis otophila, H. sulcata, Rhipicephalus bursa, R. sanguineus.

Priural Region

Ixodes persulcatus, I. ricinus.

Russian Far East

Dermacentor silvarum, D. variegatus kamtschadalus, Haemaphysalis bispinosa, H. japonica var. douglasi, Hyalomma detritum, Ixodes signatus, I. uriae.

Siberia

Dermacentor marginatus, D. niveus, D. nuttalli, D. pictus, D.

silvarum, Haemaphysalis concinna, H. warburtoni, Ixodes apronophorus, I. autumnalis, I. berlesei, I. ovatus, I. persulcatus, I. ricinus, I. uriae, I. vespertilionis, Rhipicephalus sanguineus.

Trans-Baikal Region

Dermacentor silvarum, Ixodes crenulatus, I. persulcatus, I. ricinus.

Transcaspian Region

Hyalomma detritum.
Ornithodoros tholozani.

Transcaucasia

Boophilus calcaratus, Dermacentor marginatus, D. pictus, Haemaphysalis caucasica, H. concinna, H. inermis, H. otophila, H. numidiana taurica, H. punctata, H. sulcata, H. warburtoni, Hyalomma aegyptium, H. detritum, H. dromedarii, H. excavatum, H. rufipes, H. savignyi, Ixodes arboricola bogatschevi, I. crenulatus, I. frontalis, I. redikorzevi redikorzevi, I. ricinus, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.
Ornithodoros lahorensis, O. tholozani.

Transural Region

Dermacentor marginatus, D. silvarum, Hyalomma detritum, Ixodes persulcatus, Rhipicephalus bursa.

Trans-Volga Region

Rhipicephalus sanguineus.

Turkestan

Boophilus calcaratus, Dermacentor niveus, D. pavlovskyi, D. pictus, D. raskemensis, Haemaphysalis inermis, H. numidiana turanica, H. punctata, H. sulcata, Hyalomma aegyptium, H. detritum, H. dromedarii, H. excavatum, H. savignyi, Rhipicephalus bursa, R. sanguineus.
Argas persicus, A. vespertilionis, Ornithodoros canestrinii,

O. cholodkovskyi, O. tholozani.

Ural Region

Ixodes persulcatus, I. ricinus.

Volga Region

Dermacentor marginatus, D. niveus, D. silvarum, Haemaphysalis punctata, Hyalomma detritum, H. savignyi, Ixodes laguri laguri, I. ricinus, Rhipicephalus bursa, R. rossicus, R. sanguineus.

Bering Island

Ixodes uriae.

Commander Island

Ixodes uriae.

Karlov Island

Ixodes uriae.

Kurile Islands

Ixodes angustus, I. persulcatus, I. uriae.

Sakhalin Island

Ixodes angustus, I. persulcatus.

Host List

Under the class names, the hosts are arranged alphabetically by orders. In most instances the host names given here are those used in the papers consulted. When several specific names and common names have been combined here under a single name, the synonyms follow the accepted names in parentheses.

Mammalia

Insectivora

Crocidura russula
Rhipicephalus sanguineus

Erinaceus europaeus
Haemaphysalis numidiana taurica, H. punctata, Hyalomma dromedarii, Ixodes ricinus, Rhipicephalus bursa, R. sanguineus.

Erinaceus europaeus amurensis (E. amurensis)
Haemaphysalis concinna, Ixodes persulcatus, I. pomerantzevi.

Erinaceus europaeus concolor (E. ponticus)
Ixodes redikorzevi redikorzevi.

Erinaceus europaeus roumanicus (E. rumanicus)
Dermacentor marginatus, D. niveus, D. silvarum, Haemaphysalis numidiana taurica, Ixodes ricinus, Rhipicephalus rossicus, R. sanguineus.

Erinaceus europaeus transcaucasicus (E. transcaucasicus)
Ixodes ricinus.

Erinaceus species
Haemaphysalis numidiana turanica, Ixodes ricinus, Rhipicephalus sanguineus.

"Hedgehog"
Dermacentor marginatus, D. niveus, D. pictus, D. pomerantzevi, D. silvarum, Haemaphysalis concinna, H. japonica var. douglasi, H. numidiana turanica, H. otophila, H. punctata, H. sulcata,

Hyalomma aegyptium, H. detritum, H. dromedarii, Ixodes crenulatus, I. laguri laguri, I. persulcatus, I. pomerantzevi, I. redikorzevi redikorzevi, I. ricinus, Ornithodoros species, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

"Hedgehog, Amur"
Ixodes persulcatus.

"Hedgehog, Eared"
Ixodes laguri laguri.

"Hedgehog, Turkestan"
Dermacentor niveus.

Hemiechinus auritus
Dermacentor niveus, D. silvarum, Haemaphysalis numidiana turanica, Rhipicephalus rossicus, R. sanguineus, R. schulzei.

Hemiechinus auritus albulus (H. albulus)
Dermacentor niveus, Haemaphysalis numidiana turanica, H. sulcata, Hyalomma dromedarii, Hyalomma species, Ixodes species, Rhipicephalus sanguineus.

Hemiechinus auritus brachyotis (H. calligoni brachyotis)
Ixodes redikorzevi redikorzevi.

Hemiechinus auritus turanicus (H. albulus turanicus)
Dermacentor niveus, Hyalomma dromedarii.

Hemiechinus species
Ixodes laguri laguri, Rhipicephalus schulzei.

"Insectivores"
Dermacentor marginatus, D. pictus, Haemaphysalis concinna, Ixodes persulcatus, Rhipicephalus rossicus.

"Mole"
Haemaphysalis concinna.

Neomys fodiens
Dermacentor marginatus.

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Paraechinus hypomelas
Haemaphysalis numidiana turanica.

"Shrew"
Ixodes triangulicep s.

Sorex araneus (S. vulgaris)
Dermacentor marginatus, D. pictus, Ixodes persulcatus, I. ricinus, I. trianguliceps.

Sorex minutus
Ixodes triangulicep s.

Sorex species
Dermacentor silvarum, Ixodes persulcatus, I. pomerantzevi, I. ricinus.

Chiroptera

"Bats"
Argas vespertilionis, Ixodes vespertilionis, Ornithodoros tholozani.

Rhinolophus euryale
Argas vespertilionis, Ixodes vespertilionis.

Rhinolophus ferrum-equinum
Argas vespertilionis, Ixodes vespertilionis.

Primates

Homo sapiens (man)
Argas persicus, A. reflexus, Dermacentor marginatus, D. niveus, D. nuttalli, D. pictus, D. silvarum, Haemaphysalis concinna, H. inermis, H. japonica var. douglasi, H. otophila, H. punctata, Hyalomma detritum, H. dromedarii, H. excavatum, H. savignyi, Ixodes angustus, I. kazakstani, I. persulcatus, I. ricinus, I. uriae, Ornithodoros lahorensis, Ornithodoros species, O. tholozani, O. verrucosus, Rhipicephalus rossicus, R. sanguineus, R. schulzei.

Lagomorpha

"Hares"

Dermacentor marginatus, D. nuttalli, D. pictus, D. silvarum, Haemaphysalis caucasica, H. concinna, H. japonica var. douglasi, H. otophila, H. pavlovskyi, H. punctata, H. sulcata, Hyalomma detritum, H. dromedarii, H. excavatum, H. savignyi, Ixodes persulcatus, I. redikorzevi redikorzevi, I. ricinus, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

Lepus capensis tolai (L. tolai)

Haemaphysalis sulcata, Hyalomma dromedarii.

Lepus europaeus

Dermacentor marginatus, D. silvarum, Ixodes ricinus, Rhipicephalus rossicus, R. sanguineus, R. schulzei.

Lepus europaeus transsylvanicus

Hyalomma savignyi.

Lepus mandschuricus

Dermacentor silvarum.

Lepus species

Dermacentor marginatus, D. silvarum, Haemaphysalis caucasica, H. concinna, H. sulcata, Ixodes ricinus, Rhipicephalus sanguineus.

Lepus tolai buchariensis

Dermacentor niveus, Haemaphysalis species, Hyalomma species, Rhipicephalus sanguineus.

"Rabbit"

Dermacentor marginatus, D. pictus, Haemaphysalis caucasica, H. concinna, H. inermis, H. japonica var. douglasi, H. otophila, H. pavlovskyi, H. punctata, H. sulcata, Hyalomma dromedarii, H. excavatum, Ixodes persulcatus, I. ricinus, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

Rodentia

Alactagulus pumilio (A. acontion)

Dermacentor silvarum, Rhipicephalus schulzei.

Allactaga major (A. jaculus)
Dermacentor marginatus, D. silvarum, Rhipicephalus schulzei.

Allactaga severtzovi
Hyalomma dromedarii.

Allactaga species
Dermacentor niveus.

Apodemus agrarius
Dermacentor marginatus, D. silvarum, Ixodes ricinus.

Apodemus agrarius mantschuricus
Dermacentor silvarum.

Apodemus flavicollis
Dermacentor marginatus, Ixodes ricinus, I. trianguliceps.

Apodemus peninsulae praetor (A. speciosus praetor)
Dermacentor silvarum, Ixodes persulcatus.

Apodemus sylvaticus
Dermacentor marginatus, D. silvarum, Haemaphysalis inermis, Ixodes redikorzevi redikorzevi, I. ricinus.

Arvicola species
Dermacentor silvarum.

Arvicola terrestris
Dermacentor marginatus, D. silvarum, Ixodes apronophorus, I. trianguliceps.

Arvicola terrestris amphibius (A. amphibius)
Ixodes trianguliceps, Dermacentor pictus, Dermacentor silvarum, Rhipicephalus schulzei.

Arvicola terrestris scherman (A. scherman)
Ixodes apronophorus.

"Chipmunk"
Haemaphysalis concinna, Ixodes pomerantzevi.

Citellus fulvus
Rhipicephalus schulzei.

Citellus major (C. rufescens)
Dermacentor silvarum.

Citellus pygmaeus
Dermacentor niveus, D. silvarum, Haemaphysalis numidiana turanica, H. punctata, Hyalomma dromedarii, Ixodes laguri laguri, I. redikorzevi redikorzevi, Rhipicephalus schulzei.

Citellus species
Dermacentor nuttalli, Rhipicephalus bursa, R. sanguineus, R. schulzei.

Citellus suslicus
Dermacentor marginatus, D. silvarum.

Citellus undulatus eversmanni (C. eversmanni)
Dermacentor nuttalli, D. silvarum.

Clethrionomys glareolus (Evotomys glareolus)
Dermacentor marginatus, Ixodes persulcatus, I. ricinus, I. trianguliceps.

Clethrionomys glareolus britannicus (Evotomys britannicus)
Ixodes trianguliceps.

Clethrionomys glareolus glareolus (Arvicola pratensis)
Ixodes trianguliceps.

Clethrionomys glareolus hercynicus (Evotomys hercynicus)
Ixodes trianguliceps.

Clethrionomys rufocanus (Evotomys rufocanus)
Dermacentor silvarum, Haemaphysalis concinna, Ixodes angustus, I. apronophorus, I. persulcatus, I. pomerantzevi, I. redikorzevi redikorzevi, I. trianguliceps.

Clethrionomys rutilus
Ixodes trianguliceps.

Cricetulus eversmanni (Mesocricetus eversmanni)
Rhipicephalus schulzei.

Cricetulus migratorius
Haemaphysalis sulcata, Rhipicephalus schulzei, R. sanguineus.

Cricetulus migratorius phaeus (C. phaeus)
Rhipicephalus sanguineus.

Cricetulus triton nestor
Dermacentor silvarum.

Cricetus cricetus
Dermacentor marginatus, D. niveus, D. silvarum, Ixodes laguri laguri, I. ricinus, Rhipicephalus rossicus, R. sanguineus, R. schulzei.

Cricetus cricetus cricetus (Cricetulus nigricans)
Haemaphysalis otophila.

Cricetus species
Dermacentor niveus.

"Dormouse"
Ixodes persulcatus, I. ricinus.

Dyromys nitedula
Dermacentor marginatus.

Ellobius talpinus
Rhipicephalus schulzei.

Eutamias sibiricus (E. asiaticus)
Haemaphysalis concinna, Ixodes persulcatus, I. pomerantzevi.

Eutamias sibiricus orientalis (E. asiaticus orientalis)
Dermacentor silvarum, Haemaphysalis concinna, Ixodes persulcatus.

Glis glis
Ixodes laguri colchicus.

"Gopher"
Haemaphysalis sulcata.

"Groundhog"
Haemaphysalis concinna, Ixodes ricinus.

"Hamster"
Dermacentor niveus, D. nuttalli, Hyalomma aegyptium, Ixodes laguri laguri, Rhipicephalus sanguineus.

"Hamster, Gray"
Ixodes laguri laguri.

Lagurus lagurus
Dermacentor marginatus, D. silvarum, Ixodes laguri laguri, I. redikorzevi redikorzevi, Rhipicephalus schulzei.

"Lemming"
Ixodes laguri laguri.

"Marmot"
Dermacentor nuttalli, Hyalomma detritum, H. dromedarii, Ixodes autumnalis, I. laguri laguri, Rhipicephalus schulzei.

"Marmot, Sandy"
Rhipicephalus schulzei.

"Marmot, Siberian"
Ixodes laguri laguri, I. ricinus, Rhipicephalus schulzei.

Marmota bobak (Arctomys bobac)
Dermacentor niveus, D. pictus, Rhipicephalus schulzei.

Marmota caudata
Ixodes autumnalis.

Marmota marmota centralis
Hyalomma species.

Marmota species
Ixodes autumnalis.

Meriones blackleri bogdanovi (Meriones bogdanovi)
Ixodes laguri laguri.

Meriones libycus eversmanni (Gerbillus eversmanni)
Ornithodoros tartakovskyi.

Meriones libycus erythrourus (Meriones erythrourus)
Hyalomma species, Ornithodoros tholozani.

Meriones meridianus
Rhipicephalus sanguineus, R. schulzei.

Meriones tamariscinus
Rhipicephalus sanguineus, R. schulzei.

Mesocricetus auratus
Ixodes laguri armeniacus.

Mesocricetus auratus brandti (M. brandti)
Ixodes laguri armeniacus.

Micromys minutus (Mus minutus)
Ixodes triangulicepS.

Microtus agrestis
Ixodes triangulicepS.

Microtus arvalis
Dermacentor antrorum, D. marginatus, D. pictus, D. silvarum, Hyalomma dromedarii, Ixodes apronophorus, I. laguri laguri, I. laguri armeniacus, I. ricinus, I. triangulicepS, Rhipicephalus schulzei.

Microtus fortis pelliceus (M. michnoi pelliceus)
Dermacentor silvarum.

Microtus gregalis
Dermacentor nuttalli, D. pictus.

Microtus nivalis (Chionomys nivalis)
Dermacentor antrorum, Rhipicephalus turanicus.

Microtus oeconomus ratticeps
Ixodes apronophorus.

Microtus socialis satunini
Ixodes redikorzevi redikorzevi.

Microtus species
Ixodes ricinus, Dermacentor nuttalli.

"Mouse"
Dermacentor niveus, Ixodes laguri laguri, I. redikorzevi redikorzevi, I. ricinus, I. triangulicep, Rhipicephalus sanguineus, R. schulzei.

"Mouse, Eastern Field"
Haemaphysalis concinna, Ixodes persulcatus, Dermacentor silvarum.

"Mouse, Field"
Dermacentor nuttalli, D. pictus, D. silvarum, Haemaphysalis concinna, Ixodes laguri laguri, I. persulcatus, I. ricinus.

"Mouse, Red"
Ixodes persulcatus.

"Mouse, Wood"
Haemaphysalis concinna, H. inermis, Ixodes laguri laguri, I. ricinus.

Mus musculus
Dermacentor silvarum, Rhipicephalus schulzei.

Mus musculus severtzovi
Dermacentor niveus, Ixodes species, Rhipicephalus sanguineus, R. schulzei.

Nesokia indica
Ixodes redikorzevi redikorzevi.

Ondatra species
Ixodes apronophorus.

"Porcupine"
Ornithodoros tholozani.

"Rat"
Dermacentor nuttalli, Haemaphysalis concinna, H. sulcata,

Rhipicephalus schulzei, R. sanguineus.

"Rat, Water"
Dermacentor marginatus, D. pictus, Ixodes apronophorus, I. laguri laguri.

Rattus norvegicus
Dermacentor marginatus.

Rattus norvegicus caraco
Dermacentor silvarum, Ixodes persulcatus.

Rattus rattus turkestanicus
Haemaphysalis sulcata, Rhipicephalus sanguineus, Ornithodoros tholozani.

Rhombomys opimus
Haemaphysalis numidiana turanica, Hyalomma species, Ixodes occultus, Ornithodoros species, Ornithodoros tartakovskyi, Rhipicephalus schulzei, Rhipicephalus species.

"Rodent"
Dermacentor marginatus, D. niveus, D. nuttalli, D. pictus, D. silvarum, Haemaphysalis bispinosa, H. concinna, H. japonica, var. douglasi, H. punctata, Ixodes apronophorus, I. crenulatus, I. laguri laguri, I. persulcatus, I. ricinus, I. triangulicepe, Ornithodoros nereensis, Ornithodoros species, O. tartakovskyi, O. tholozani, Rhipicephalus rossicus, R. sanguineus, R. schulzei.

Sciurus vulgaris
Dermacentor silvarum, Haemaphysalis concinna, Ixodes persulcatus.

Sicista species
Ixodes angustus.

Sicista subtilis nordmanni (S. nordmanni)
Dermacentor marginatus.

Spalax microphthalmus
Dermacentor marginatus, D. silvarum.

Spermophilopsis leptodactylus
Haemaphysalis numidiana turanica, Hyalomma species.

"Squirrel"
Dermacentor marginatus, Haemaphysalis concinna, Ixodes persulcatus, I. ricinus.

"Squirrel, Ground"
Rhipicephalus schulzei.

Carnivora

"Badger"
Haemaphysalis bispinosa, H. concinna, H. japonica var. douglasi, Ixodes autumnalis, I. crenulatus, I. ricinus.

"Bear"
Haemaphysalis caucasica, H. concinna, H. japonica var. douglasi, H. numidiana taurica.

Canis aureus
Rhipicephalus sanguineus.

"Cat" (Felis domesticus)
Dermacentor marginatus, D. nuttalli, D. silvarum, Haemaphysalis sulcata, Hyalomma species, Ixodes laguri laguri, I. persulcatus, I. ricinus, Rhipicephalus rossicus, R. sanguineus, R. schulzei.

"Dog" (Canis familiaris)
Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. nuttalli, D. pictus, D. silvarum, Haemaphysalis bispinosa, H. concinna, H. inermis, H. japonica var. douglasi, H. otophila, H. punctata, H. sulcata, Hyalomma aegyptium, H. detritum, H. savignyi, Ixodes crenulatus, I. persulcatus, I. ricinus, Ornithodoros lahorensis, O. tholozani, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

Felis bengalensis euptilura (Prionailurus euptilura)
Haemaphysalis concinna.

Felis pardus
Haemaphysalis concinna.

Felis pardus fontanierii (Leopardus pardus fontanieri)
Haemaphysalis concinna.

Felis tigris amurensis (Tigris tigris amurensis)
Dermacentor silvarum, Haemaphysalis concinna, Ixodes persulcatus.

"Forest Cat, Far East"
Haemaphysalis concinna.

"Fox"
Dermacentor marginatus, D. pictus, D. silvarum, Haemaphysalis caucasica, H. concinna, H. inermis, Hyalomma detritum, Ixodes crenulatus, I. persulcatus, I. ricinus, Rhipicephalus rossicus, R. sanguineus, R. schulzei.

"Jackal"
Haemaphysalis caucasica, Ixodes crenulatus, Rhipicephalus sanguineus, R. schulzei.

"Leopard"
Haemaphysalis concinna.

"Lynx"
Haemaphysalis japonica var. douglasi, Ixodes persulcatus.

Martes foina (Mustela foina)
Haemaphysalis numidiana taurica, Ixodes ricinus.

Meles meles
Haemaphysalis concinna, Rhipicephalus sanguineus.

Meles meles tauricus
Ixodes ricinus.

Meles meles transcaucasicus
Ixodes crenulatus.

Mustela nivalis
Dermacentor marginatus, D. silvarum, Ixodes ricinus.

Mustela putorius eversmanni (Putorius eversmanni)
Dermacentor marginatus, D. pictus, D. silvarum, Haemaphysalis numidiana turanica, Ixodes laguri laguri, I. ricinus, R. schulzei.

Mustela sibirica (Kolonocus sibericus)
Dermacentor silvarum, Ixodes persulcatus.

Mustela sibirica coreana (Kolonocus sibericus coreanus)
Dermacentor silvarum.

Mustela species.
Rhipicephalus schulzei.

Nyctereutes procyonoides
Dermacentor silvarum, Haemaphysalis concinna, Ixodes persulcatus.

"Polecat"
Ixodes autumnalis, I. laguri laguri, Rhipicephalus bursa, R. sanguineus, R. schulzei.

"Tiger"
Dermacentor silvarum.

Vormela peregusna (V. sarmatica)
Haemaphysalis numidiana turanica, Ixodes redikorzevi redikorzevi, Rhipicephalus sanguineus.

Vormela species
Haemaphysalis numidiana turanica.

"Walrus"
Hyalomma aegyptium.

"Weasel"
Ixodes laguri laguri.

"Wolf" (Canis lupus)
Dermacentor marginatus, D. pictus, D. silvarum, Haemaphysalis concinna, Hyalomma detritum, Ixodes crenulatus, I. persulcatus, I. ricinus.

Perissodactyla

"Donkey" (Equus asinus)
Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. pictus, Haemaphysalis otophila, H. punctata, Hyalomma aegyptium, H. detritum, H. dromedarii, H. excavatum, H. savignyi, Ornithodoros lahorensis, Rhipicephalus bursa, R. sanguineus.

Equus hemionus
Dermacentor nuttalli.

"Horse" (Equus caballus)
Argas reflexus, Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. nuttalli, D. pictus, D. silvarum, Haemaphysalis bispinosa, H. concinna, H. inermis, H. japonica var. douglasi, H. otophila, H. punctata, H. sulcata, Hyalomma detritum, H. dromedarii, H. excavatum, H. savignyi, Ixodes persulcatus, I. ricinus, Ornithodoros tholozani, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

Artiodactyla

Alces alces cameloides (Alces alces americanus n. bedfordi)
Ixodes persulcatus.

"Bison"
Rhipicephalus bursa, R. sanguineus.

"Buffalo"
Boophilus calcaratus, Dermacentor marginatus, D. pictus, D. silvarum, Haemaphysalis concinna, H. inermis, H. otophila, H. punctata, H. sulcata, Hyalomma detritum, H. excavatum, H. savignyi, Rhipicephalus bursa, R. rossicus, R. sanguineus.

"Camel" (Camelus bactrianus)
Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. nuttalli, D. silvarum, Haemaphysalis otophila, H. punctata, H. sulcata, Hyalomma aegyptium, H. detritum, H. dromedarii, H. excavatum, H. rufipes, H. savignyi, H. schulzei, Ornithodoros lahorensis, O. tholozani, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

Capreolus capreolus (Cervus capreolus)
Dermacentor marginatus, Haemaphysalis concinna, Hyalomma detritum, Ixodes ricinus.

Capreolus capreolus bedfordi (C. pygargus bedfordi)
Dermacentor silvarum.

"Cattle" (Ox, Calves, Bos taurus)
Boophilus calcaratus, Dermacentor niveus, D. marginatus, D. nuttalli, D. pavlovskyi, D. pictus, D. silvarum, Haemaphysalis bispinosa, H. concinna, H. inermis, H. japonica var. douglasi, H. numidiana taurica, H. numidiana turanica, H. otophila, H. punctata, H. sulcata, H. warburtoni, Hyalomma detritum, H. dromedarii, H. excavatum, H. savignyi, H. schulzei, Ixodes persulcatus, I. ricinus, Ornithodoros lahorensis, O. tholozani, Rhipicepahlus bursa, R. rossicus, R. sanguineus, R. schulzei.

Cervus elaphus (C. canadensis)
Dermacentor marginatus, D. silvarum, Ixodes ricinus.

Cervus elaphus bactrianus (C. bactrianus, C. affinis bactrianus)
Boophilus calcaratus, Dermacentor niveus, Hyalomma detritum.

Cervus elaphus xanthopygus (C. canadensis xanthopygaeus)
Dermacentor silvarum, Haemaphysalis concinna, Ixodes persulcatus.

Cervus nippon hortulorum (C. hortulorum, Sikka hortulorum)
Dermacentor silvarum, Haemaphysalis concinna, H. japonica var. douglasi, Ixodes persulcatus.

Cervus species
Haemaphysalis concinna.

Dama dama (Cervus dama, Dama vulgaris)
Haemaphysalis punctata, H. sulcata, Ixodes ricinus.

"Deer"
Boophilus calcaratus, Dermacentor marginatus, D. pictus, D. silvarum, D. variegatus kamtschadalus, Haemaphysalis bispinosa, H. concinna, H. inermis, H. japonica var. douglasi, H. otophila, H. punctata, H. sulcata, Hyalomma detritum, Ixodes ricinus, Rhipicephalus bursa.

"Deer, Manchurian"
Dermacentor silvarum.

"Deer, Roe"
Haemaphysalis concinna, Dermacentor silvarum.

"Deer, Spotted"
Dermacentor silvarum, Haemaphysalis bispinosa, H. concinna, H. japonica var. douglasi.

"Elk"
Ixodes persulcatus, I. ricinus.

Gazella subgutturosa (Antiolopa subgutturosa)
Hyalomma detritum, Hyalomma species, Rhipicephalus sanguineus.

"Gazelle"
Ixodes persulcatus, I. ricinus.

"Goats"
Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. pavlovskyi, D. pictus, D. silvarum, Haemaphysalis concinna, H. inermis, H. otophila, H. punctata, H. sulcata, H. warburtoni, Hyalomma detritum, H. dromedarii, H. excavatum, H. savignyi, Ixodes persulcatus, I. ricinus, Ornithodoros lahorensis, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

Hydropotes inermis
Haemaphysalis bispinosa.

Moschus moschiferus parvipes
Ixodes persulcatus.

"Moufflon"
Dermacentor marginatus.

Muntiacus species (Cervulus species)
Haemaphysalis bispinosa.

Naemorhedus cinereus
Haemaphysalis bispinosa.

Ovis musimon
Haemaphysalis sulcata.

Ovis nigrimontana
Dermacentor pavlovskyi.

Ovis orientalis bochariensis (O. vignei bokhariensis)
Boophilus calcaratus, Hyalomma species.

Ovis orientalis cycloceros
Haemaphysalis sulcata.

Ovis species
Dermacentor variegatus kamtschadalus.

"Pig" (Boar, Sus scrofa)
Dermacentor marginatus, D. niveus, D. pictus, D. silvarum, Haemaphysalis punctata, Hyalomma detritum, H. dromedarii, H. savignyi, Ixodes persulcatus, I. ricinus, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

Rangifer tarandus
Dermacentor variegatus kamtschadalus.

"Serow"
Haemaphysalis warburtoni.

"Sheep"
Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. nuttalli, D. pavlovskyi, D. pictus, D. silvarum, D. variegatus kamtschadalus, Haemaphysalis concinna, H. inermis, H. otophila, H. punctata, H. sulcata, Hyalomma detritum, H. dromedarii, H. excavatum, H. savignyi, Ixodes persulcatus, I. ricinus, Ornithodoros lahorensis, O. tholozani, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

"Zebu"
Boophilus calcaratus, Dermacentor niveus, D. silvarum, Haemaphysalis concinna, H. inermis, H. punctata, Hyalomma detritum, H. excavatum, H. rufipes, H. savignyi, Ixodes ricinus, Rhipicephalus bursa.

Hosts listed only as domestic animals
Argas persicus, Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. nuttalli, D. pictus, D. silvarum, Haemaphysalis bispinosa, H. concinna, H. inermis, H. japonica var douglasi, H. otophila, H. punctata, H. sulcata, H. warburtoni, Hyalomma detritum, H. dromedarii, H. excavatum, H. rufipes, H. savignyi, Hyalomma species, Ixodes persulcatus, I. ricinus, Ornithodoros

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lahorensis, O. tholozani, Rhipicephalus bursa, R. rossicus, R. sanguineus, R. schulzei.

Aves

Sphenisciformes

"Penguin"
Ixodes uriae.

Pelecaniformes

"Cormorant"
Ixodes uriae.

Phalacrocorax pelagicus
Ixodes signatus.

Phalacrocorax penicillatus
Ixodes signatus.

Phalacrocorax species
Ixodes signatus.

Anseriformes

Anser anser
Ixodes frontalis.

"Duck"
Argas persicus, Hyalomma species.

"Geese"
Argas persicus, A. reflexus.

Falconiformes

Falco rusticolus candicans (F. candicans)
Ixodes berlesei.

Milvus lineatus lineatus (M. korschun lineatus)
Haemaphysalis concinna.

Neophron percnopterus
Hyalomma species.

Gruiformes

Crex crex
Ixodes frontalis.

Grus grus
Hyalomma savignyi.

"Water pullet"
Ixodes apronophorus.

Passeriformes

Accentor collaris
Ixodes semenovi.

Alauda arvensis
Haemaphysalis concinna, Ixodes persulcatus.

Alauda gulgula inconspicua
Hyalomma species.

Anthus campestris campestris
Haemaphysalis punctata, H. sulcata.

Anthus campestris griseus
Hyalomma species.

Anthus hodgsoni
Dermacentor silvarum, Haemaphysalis concinna, Ixodes persulcatus.

Anthus pratensis
Ixodes frontalis.

Anthus trivialis
Ixodes frontalis, I. persulcatus, I. ricinus.

Calandrella acutirostris
Hyalomma species.

Calandrella cinerea
Hyalomma species.

Carduelis carduelis subcaniceps
Hyalomma species.

Chloris chloris
Ixodes frontalis, I. ricinus.

Coccothraustes coccothraustes japonicus
Ixodes persulcatus.

Corvus cornix cornix
Ixodes persulcatus.

Corvus corone orientalis
Ixodes persulcatus.

Cractes infaustus maritimus
Ixodes persulcatus.

Cyanocitta stelleri frontalis
Ixodes frontalis.

Emberiza aureola ornata
Dermacentor silvarum, Haemaphysalis concinna, Ixodes persulcatus.

Emberiza buchanani huttoni
Hyalomma species.

Emberiza calandra
Haemaphysalis punctata.

Emberiza citrinella
Ixodes persulcatus.

Emberiza icterica
Hyalomma species.

Emberiza melanocephala
Haemaphysalis sulcata.

Emberiza schoeniclus
Ixodes frontalis, I. redikorzevi emberizae, I. persulcatus.

Emberiza spodocephala extremi-orientis
Dermacentor silvarum, Haemaphysalis concinna, Ixodes persulcatus.

Emberiza stewarti
Hyalomma species.

Erithacus rubecula
Ixodes frontalis.

"Finch, Mountain"
Ixodes frontalis.

Fringilla albicollis
Ixodes frontalis.

Fringilla montifringilla
Ixodes frontalis.

Galerida cristata
Ixodes redikorzevi redikorzevi.

Galerida cristata caucasica
Haemaphysalis punctata, H. sulcata, Hyalomma savignyi.

Garrulus glandarius brandtii
Ixodes persulcatus.

Garrulus glandarius krynickii
Ixodes ricinus.

Garrulus iphigenia
Hyalomma species, Ixodes frontalis, I. ricinus.

Habia melanocephala
Ixodes frontalis.

Hirundo rustica
Hyalomma species.

Lanius collurio isabellinus
Hyalomma species.

Lanius minor
Hyalomma species.

"Lark"
Haemaphysalis punctata, H. sulcata.

Locustella lanceolata
Ixodes persulcatus.

Luscinia calliope (Calliope calliope)
Haemaphysalis concinna, Ixodes persulcatus.

"Magpie"
Haemaphysalis concinna, Ixodes persulcatus.

Melanocorypha calandra
Haemaphysalis otophila, Hyalomma savignyi, Hyalomma species.

Merula merula aterrima
Ixodes frontalis, I. ricinus.

Miliaria calandra buturlini
Hyalomma species.

Monticola solitaria pandoo
Ixodes berlesei.

Muscicapa daurica
Ixodes persulcatus.

"Nightingale"
Haemaphysalis concinna, Ixodes persulcatus.

Oenanthe capistrata
Hyalomma species.

Oenanthe opostholeuca
Hyalomma species, Ixodes redikorzevi redikorzevi.

Oenanthe species
Haemaphysalis sulcata.

"Ouzel" (Cinclus species)
Haemaphysalis concinna, Ixodes persulcatus.

Parus major
Ixodes frontalis, I. ricinus.

Passer domesticus bactrianus
Hyalomma species.

Passer montanus
Ixodes frontalis, I. persulcatus.

Passer montanus zaissanensis
Hyalomma species.

Passer species
Hyalomma savignyi.

Pastor roseus
Hyalomma species.

Penthestes atricapillus borealis
Ixodes persulcatus.

Phoenicurus ochrurus phoenicuroides
Hyalomma species, Ixodes berlesei.

Phragamaticola aedon rufescens
Dermacentor silvarum, Haemaphysalis concinna, Ixodes persulcatus.

Phylloscopus collybitus
Ixodes redikorzevi redikorzevi.

Phylloscopus fuscatus
Dermacentor silvarum, Ixodes persulcatus.

Phylloscopus nitidus viridanus
Hyalomma species.

Pica species
Hyalomma savignyi.

Piranga ludoviciana
Ixodes frontalis.

Poecile palustris crassirostris
Haemaphysalis concinna.

Prunella collaris
Ixodes semenovi.

"Raven"
Haemaphysalis concinna, Ixodes persulcatus.

Regulus regulus
Ixodes frontalis.

"Rook"
Haemaphysalis punctata.

Saxicola rubetra
Ixodes frontalis.

Saxicola torquata
Hyalomma species, Ixodes redikorzevi redikorzevi.

Saxicola torquata rubicola
Ixodes frontalis.

Sitta caesia
Ixodes frontalis.

Sitta europaea
Ixodes arboricola bogatschevi.

Sitta europaea amurensis
Dermacentor silvarum, Ixodes persulcatus.

Sitta europaea caucasica
Ixodes arboricola bogatschevi, I. ricinus.

Sitta neumayer neumayer
Haemaphysalis sulcata.

Sitta tephronota
Argas species, Hyalomma species.

"Sparrow"
Haemaphysalis concinna, H. sulcata, Hyalomma savignyi, Ixodes persulcatus.

"Starling"
Haemaphysalis concinna, H. punctata, Ixodes berlesei, I. persulcatus.

Sturnus vulgaris
Ixodes berlesei.

Sturnus vulgaris dresseri (S. purpurascens abb. dresseri)
Haemaphysalis punctata, Hyalomma species, Ixodes species.

"Swallow"
Ixodes plumbeus.

Sylvia althaea
Hyalomma species.

Sylvia curruca
Hyalomma species.

"Thrush"
Ixodes apronophorus, I. frontalis, I. redikorzevi redikorzevi.

Turdus aona loschkae
Ixodes frontalis.

Turdus atrogularis
Ixodes redikorzevi redikorzevi.

Turdus hortulorum
Ixodes persulcatus.

Turdus merula
Ixodes frontalis.

Turdus musicus
Ixodes persulcatus.

Turdus pallidus
Ixodes persulcatus.

Turdus philomelos
Ixodes ricinus.

Turdus piloris
Ixodes frontalis.

Turdus species
Ixodes ricinus.

Turdus viscivorus
Haemaphysalis punctata.

Uragus sibiricus ussuriensis
Ixodes persulcatus.

"Yellowhammer"
Haemaphysalis concinna, Ixodes persulcatus.

Galliformes

Alectoris kahelik kahelik
Hyalomma species.

"Domestic Fowl"
Hyalomma savignyi.

"Fowl"
Argas persicus.

Gallus domesticus
Argas persicus, A. reflexus, Haemaphysalis punctata, Hyalomma species, Ornithodoros tholozani, Rhipicephalus sanguineus.

"Grouse"
Haemaphysalis concinna, Ixodes pavlovskyi, I. persulcatus.

Lyrurus tetrix
Ixodes persulcatus.

"Partridge"
Hyalomma species.

"Partridge, Gray"
Hyalomma species.

Perdix perdix
Hyalomma savignyi.

Phasianus colchicus bianchii (P. chrysomelas bianchii)
Haemaphysalis pavlovskyi, Haemaphysalis species, Hyalomma species.

Phasianus colchicus turcestanicus
Haemaphysalis punctata, Ixodes ricinus.

"Pheasant"
Haemaphysalis pavlovskyi, H. punctata, Ixodes kazakstani, I. ricinus.

Tetrastes bonasia
Haemaphysalis concinna, Ixodes pavlovskyi, I. persulcatus.

"Turkey"
Haemaphysalis punctata, Haemaphysalis species.

Charadriiformes

Burhinus oedicnemus
Hyalomma species.

Capella megala
Dermacentor silvarum, Haemaphysalis concinna, Ixodes persulcatus.

Rissa tridactyla
Ixodes uriae.

"Sea Gull"
Ixodes uriae.

Uria lomvia
Ixodes uriae.

Uria lomvia arra
Ixodes uriae.

Uria troile
Ixodes uriae.

Columbiformes

Columba eversmanni
Hyalomma species.

Columba livia neglecta
Hyalomma species.

"Dove"
Argas reflexus.

"Pigeon"
Ixodes berlesei.

Streptopelia turtur arenicola
Hyalomma species.

Strigiformes

Aegolius funereus
Hyalomma species.

Asio flammeus
Ixodes persulcatus.

Athene noctua
Hyalomma species.

Otus brucei
Argas species.

"Owl"
Hyalomma species.

Piciformes

Dendrocopas minor amurensis (Leuconotopicus minor amurensis)
Dermacentor silvarum.

Jynx torquilla
Haemaphysalis concinna.

Coraciiformes

Coracias garrula
Hyalomma species.

Merops persica
Hyalomma species.

Upupa epops
Haemaphysalis sulcata, Hyalomma savignyi, Hyalomma species.

Caprimulgiformes

Caprimulgus europaeus unwini
Rhipicephalus species.

Hosts listed only as birds

Dermacentor nuttalli, D. silvarum, Haemaphysalis concinna, H. japonica var. douglasi, H. numidiana taurica, H. otophila, H. punctata, H. sulcata, Hyalomma detritum, H. dromedarii, H. savignyi, Hyalomma

species, Ixodes berlesei, I. frontalis, I. persulcatus, I. redikorzevi redikorzevi, I. ricinus, I. uriae, Ornithodoros species, O. tholozani, O. verrucosus.

Reptilia

Chelonia

Testudo horsfieldi
Haemaphysalis sulcata, Hyalomma aegyptium.

Testudo ibera
Hyalomma aegyptium.

Testudo species
Hyalomma aegyptium, Ornithodoros tartakovskyi.

"Tortoise"
Hyalomma aegyptium, Ornithodoros tholozani, Ornithodoros species.

"Turtle"
Haemaphysalis sulcata, Hyalomma aegyptium, Ornithodoros tholozani, Rhipicephalus sanguineus.

Sauria

Agama aralensis
Haemaphysalis sulcata.

Agama lehmanni
Haemaphysalis sulcata.

Agama species
Haemaphysalis sulcata.

Albephorus deserti
Haemaphysalis sulcata.

Eremias arguta
Haemaphysalis sulcata.

Eremias parduloides
Haemaphysalis sulcata.

Eremias pleskei
Haemaphysalis sulcata.

Eremias regeli
Haemaphysalis caucasica, H. sulcata.

Eremias stravehi
Haemaphysalis sulcata.

Eremias variabilis
Haemaphysalis sulcata.

Eremias velox
Haemaphysalis sulcata.

Eumeces pavimentactus
Haemaphysalis sulcata.

Eumeces schneideri
Haemaphysalis caucasicus, H. sulcata.

Gymnodactylus fedtschenkoi
Haemaphysalis sulcata.

Lacerta agilis
Haemaphysalis otophila, H. sulcata.

Lacerta depressa
Haemaphysalis sulcata.

Lacerta species
Haemaphysalis sulcata.

Lacerta taurica
Haemaphysalis otophila, H. sulcata.

Lacerta viridis
Haemaphysalis sulcata.

"Lizards"
Haemaphysalis otophila, H. punctata, H. sulcata, Hyalomma aegyptium, Ixodes redikorzevi redikorzevi, I. ricinus.

"Lizard, Green"
Haemaphysalis punctata.

"Lizard, Scyncyan"
Haemaphysalis sulcata.

Ophiosaurus apus
Haemaphysalis sulcata.

Ophisaurus apodus
Ixodes redikorzevi redikorzevi.

Phrynocephalus helioscopus horvathi
Haemaphysalis sulcata.

Stellio caucasica
Haemaphysalis sulcata.

Stellio microlepis
Haemaphysalis sulcata.

Serpentes

Coluber ravergieri
Haemaphysalis sulcata.

Contia punctatolineata
Haemaphysalis sulcata.

Coronella austriaca
Haemaphysalis sulcata.

"Grass Snake"
Haemaphysalis sulcata.

"Runner"
Haemaphysalis sulcata.

"Snakes"
Haemaphysalis punctata, Ixodes ricinus.

Vipera renardi
Ixodes ricinus.

"Vipers"
Haemaphysalis sulcata.

Hosts listed only as reptiles

Haemaphysalis concinna, H. otophila, H. punctata, H. sulcata, Hyalomma detritum, H. dromedarii, H. savignyi, Ixodes persulcatus, I. ricinus, Ornithodoros nereensis, O. tholozani, O. verrucosus.

Relationship to Disease

In the U. S. S. R. and in the surrounding countries the following kinds of pathogens were naturally or experimentally carried by ticks: spirochaetes, protozoa, rickettsiae, bacteria and viruses. Other tick-caused conditions reported in this area were tick paralysis, death due to heavy infestations, and reaction to bites. The following list is a summary of the tick species involved either naturally or experimentally in the diseases caused by these pathogens and of the ticks which produce various effects in their hosts. More information can be found under the treatment of the individual species.

Spirochaetes

Relapsing Fever - Ornithodoros cholodkovskyi, O. nereensis, O. tartakovskyi, O. tholozani, O. verrucosus.

Spirochaetosis of cattle - Boophilus calcaratus.

Spirochaetosis of fowl - Argas persicus, A. reflexus.

Protozoa

Anaplasmosis of domestic animals - Boophilus calcaratus, Dermacentor marginatus, D. silvarum, Rhipicephalus bursa, Ornithodoros lahorensis.

Piroplasmosis of domestic animals - Boophilus calcaratus, Dermacentor marginatus, D. niveus, D. nuttalli, D. pictus, D. silvarum, Haemaphysalis otophila, H. punctata, Hyalomma detritum, H. dromedarii, H. excavatum, H. savignyi, Ixodes persulcatus, I. ricinus, Rhipicephalus bursa, R. sanguineus, R. schulzei, Ornithodoros lahorensis.

Rickettsiae

Marseilles Fever - Rhipicephalus sanguineus.

Tick-borne typhus - Dermacentor marginatus, D. nuttalli, D. silvarum, Haemaphysalis concinna, H. japonica var. douglasi, H. punctata, Ornithodoros lahorensis.

Rickettsiosis of domestic animals - Hyalomma savignyi.

Bacteria

Tularemia - Dermacentor marginatus, D. pictus, D. silvarum, Haemaphysalis punctata, Rhipicephalus rossicus, R. schulzei, Ixodes apronophorus, I. laguri laguri, I. persulcatus, Ornithodoros lahorensis.

Brucellosis - Dermacentor marginatus, Haemaphysalis punctata, H. sulcata, Hyalomma savignyi, Ornithodoros lahorensis.

Plague - Dermacentor marginatus, D. niveus, Hyalomma detritum, Ixodes autumnalis, I. crenulatus, Rhipicephalus schulzei, Argas persicus.

Virus

Bukovinian Haemorrhagic Fever - Ixodes ricinus.

Crimean Haemorrhagic Fever - Hyalomma savignyi.

Omsk Haemorrhagic Fever - Dermacentor pictus.

Uzbek Haemorrhagic Fever - Hyalomma detritum, H. excavatum, Rhipicephalus sanguineus.

Spring-Summer Encephalitis - Dermacentor marginatus, D. nuttalli, D. silvarum, Haemaphysalis concinna, H. japonica var. douglasi, Hyalomma dromedarii, H. excavatum, Ixodes persulcatus, I. ricinus, I. trianguliceps.

Japanese-B Encephalitis - Ixodes ricinus, Dermacentor marginatus.

Equine Encephalomyelitis - Dermacentor marginatus, D. pictus.

Louping Ill of Sheep - Ixodes ricinus.

Unclassed Diseases

Tick Paralysis - Boophilus calcaratus, Haemaphysalis inermis, H. punctata, H. sulcata, Hyalomma savignyi, Ixodes crenulatus, Rhipicephalus bursa, R. sanguineus, Ornithodoros lahorensis.

Dermatitis - Dermacentor nuttalli.

Death due to heavy infestation - Dermacentor nuttalli, D. pictus.

Bite reaction - Ixodes persulcatus, I. ricinus, Ornithodoros tholozani.

Family Ixodidae

Boophilus calcaratus (Birula)

Ixodes calcaratus Birula, 1895: 137.
Rhipicephalus calcaratus Birula, 1895: 361 - 363.
Boophilus calcaratus, Olenev, 1929: 48; Olenev, 1930: 604 - 610; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev and Kastrov, 1932: 28 - 30; Olenev, 1934: 367 - 388; Pospelova-Shtrom, 1935: 135 - 148; Kurchatov, 1935: 115 - 123; Zasukhin, 1935: 1 - 159; Markov and Bogorditzsky, 1935: 110 - 114; Pospelova-Shtrom, 1935: 115 - 134; Galuzo, et al., 1935: 167 - 185; Matikashvili, 1936: 237 - 249; Shternogold and Getzonok, 1938: 12 pp.; Pomerantzev and Matikashvili, 1940: 100 - 133; Kurchatov and Sokolov, 1940: 35; Kurchatov, 1940: 26 - 29; Kurchatov, 1940: 32; Tzelishcheva, 1941: 34 - 36; Galuzo, 1941: 51 - 55; Pavlovsky, et al., 1941: 48 - 50; Korneev, 1941: 24; Chizh, 1941: 58 - 60; Tzelishcheva, 1941: 63 - 64; Galuzo, 1943: 50 - 68; Galuzo, 1943: 85 - 96; Galuzo, 1943: 97 - 105; Bernadskaya, 1944: 44; Pavlovsky, 1945: 65 - 92; Pomerantzev, 1946: 1 - 28; Lototsky and Pokrovsky, 1946: 64 - 74; Matikashvili, 1948: 97 - 113; Nikolsky, 1948: 29 - 33; Pavlovsky, 1948: 600 - 601; Pomerantzev, 1950: 128 - 131; Alfeev, 1951: 398 - 403; Melnikova, 1953: 422 - 434.
Margaropus (Boophilus) calcaratus, Marzinovsky, 1917: 84 - 86.
Margaropus annulatus calcaratus, Neumann, 1911: 48; Yakimov, 1917: 298 - 301.
Margaropus calcaratus, Yakimov, 1922: 41 - 46.
Boophilus annulatus calcaratus, Yakimov and Vasilevskaya, 1924: 52 - 64; Zakharov, 1926: 53 - 59; Yakimov, et al., 1926: 224 - 258; Yakimov, et al., 1928: 644 - 646; Olenev, 1928: 84 - 96; Yakimov and Rastegaeva, 1928: 514 - 521; Olenev, 1929; 43 - 48; Yakimov and Rastegaeva, 1929: 69 - 73; Yakimov, et al., 1929: 137 - 152; Yakimov, 1929: 620; Yakimov, 1929: 311 - 321; Yakimov, 1929: 98 - 101; Yakimov, et al., 1934: 235 - 254; Zolotarev, 1934: 217 - 227.
Boophilus annulatus var. calcaratus, Olenev, 1929: 305 - 314.
Boophilus annulatus, Knuth, et al., 1918: 241 - 264; Yakimov and Vasilevskaya, 1926: 192 - 210; Olenev, 1934: 367 - 388; Kurchatov and Kalmikov, 1934: 80 pp.; Zasukhin, 1935: 261 - 264; Galuzo and Bespalov, 1935: 199 - 204; Mlinac and Oswald, 1936: 415 - 421; Zasukhin, 1937: 457 - 460.

Boophilus calcaratus balcanicus, Mlinac and Oswald, 1937: 277 - 297; Oswald, 1937: 265 - 273.
Boophilus (Margaropus) calcaratus, Cernaianu, 1937: 281 - 293.

Localities and Hosts

Europe

Europe - southern part (Olenev, 1931: 126 - 139). Balkan Peninsula - (Pomerantzev, 1950: 128 - 131). Bulgaria - Sofia; Burgas (Olenev, 1934: 367 - 388). Jugoslavia - (Mlinac and Oswald, 1936: 415 - 421; Oswald, 1937: 265 - 273), on cattle (Mlinac and Oswald, 1937: 277 - 297); Uskiub (Olenev, 1934: 367 - 388). Macedonia - on horses (Knuth, et al., 1918: 241 - 264). Rumania - (Neumann, 1911: 48; Olenev, 1934: 367 - 388), on cattle (Cernaianu, 1937: 281 - 293).

Asia

Asia Minor - (Pomerantzev, 1950: 128 - 131). Iran - (Pomerantzev, 1950: 128 - 131).

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Azerbaijan S. S. R. - on zebu (Yakimov, et al., 1934: 235 - 254). Georgian S. S. R. - on cattle (Matikashvili, 1936: 237 - 249); Tibilisi (Olenev, 1934: 367 - 388). Kazakh S. S. R. - on domestic animals (Galuzo, 1941: 51 - 55); southern part (Galuzo, 1943: 85 - 96), on cattle (Tzelishcheva, 1941: 63 - 64: Tzelishcheva, 1941: 34 - 36; Kurchatov, 1935: 115 - 123); southern and southeastern parts (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131); Aulie-Ata; Dzharkent; Merv; Novy Chardzhui (Olenev, 1934: 367 - 388); Yuzhno - Kazakh Province: near Tashkent, on cattle (Olenev, 1930: 604 - 610). Kirghiz S. S. R. - (Pomerantzev, 1946: 1 - 28); Karakol; Nayrn; valley of Syr Darya (Pomerantzev, 1950: 128 - 131).

R. S. F. S. R. - (Yakimov, 1922: 41 - 46); southern part, on cattle (Yakimov and Vasilevskaya, 1926: 192 - 210; Yakimov and Vasilevskaya, 1924: 52 - 64); Archangel Province: Archangel (Olenev, 1934: 367 - 388); Grozny Province: Chernyy Rynok (Olenev, 1934: 367 - 388), on cattle (Olenev and Kastrov, 1932: 28 - 30); Talovka, on cattle; Kolkhoz "Lighthouse of Revolution," on cattle; Razdolnoe, on cattle (Olenev and Kastrov, 1932: 28 - 30).

Tadzhik S. S. R. - (Lototsky and Pokrovsky, 1946: 64 - 74), on

cattle (Galuzo, 1943: 97 - 105; Pospelova-Shtrom, 1935: 135 - 148; Kurchatov, 1935: 115 - 123; Pavlovsky, et al., 1941: 48 - 50), domestic and wild animals, sheep, goats, horses (Pospelova-Shtrom, 1935: 135 - 148), Cervus affinis bactrianus, Ovis vignei bokhariensis (Pospelova-Shtrom, 1935: 115 - 134); western part (Pomerantzev, 1946: 1 - 28); Zeravschen (Pomerantzev, 1950: 128 - 131); Gissar Valley (Galuzo, 1943: 85 - 96), on cattle (Galuzo, et al., 1935: 167 - 185; Pospelova-Shtrom, 1935: 135 - 148; Galuzo, 1943: 50 - 68; Galuzo and Bespalov, 1935: 199 - 204), domestic animals (Pavlovsky, 1945: 65 - 92; Galuzo, 1943: 50 - 68), horses (Galuzo, 1943: 50 - 68); Leninabad Province: Leninabad (Pomerantzev, 1950: 128 - 131); Ura-Tyubá (Olenev, 1934: 367 - 388); Stalinabad Province; Kirovabad (Pomerantzev, 1950: 128 - 131); Vorzobstroi, on cattle; Kurgan Tyube, on cattle; Vakhshstroy, on cattle; Sarai-Kamar, on cattle (Pospelova-Shtrom, 1935: 135 - 148); Kulyab Province: on cattle (Pospelova-Shtrom, 1935: 135 - 148); Kulyab (Pomerantzev, 1950: 128 - 131); Novabad Province: Garm (Pomerantzev, 1950: 128 - 131).

Turkmen S. S. R. - (Pomerantzev, 1946: 1 - 28), on cattle (Kurchatov, 1935: 115 - 123); Kopet-daga; Ala-daga; Amu Darya Valley; Oasis Merv (Pomerantzev, 1950: 128 - 131); Ashkabad Province: Kyzyl-Arvat (Olenev, 1934: 367 - 388); Mary Province: Bayram Ali, Iolotan; Chardzhou Province: Kerki; Chardzhou (Pomerantzev, 1950: 128 - 131). Ukrainian S. S. R. - on cattle (Kurchatov, 1935: 115 - 123); southern part (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131); Vinnitsa Province: Vinnitsa; Kirovograd Province: Znamenka (Olenev, 1934: 367 - 388). Uzbek S. S. R. - (Pomerantzev, 1946: 1 - 28), on cattle (Kurchatov, 1935: 115 - 123); eastern part, on cattle (Galuzo, 1943: 97 - 105); near Fergana, on cattle (Lototsky and Pokrovsky, 1946: 64 - 74); Amu Darya and Syr Darya Valley; Surchan Darya; Kara Darya; Kaschka Darya; Bekbudin; Khodzent and their vicinity (Pomerantzev, 1950: 128 - 131); Samarkand Province: Katta-Kurgan (Olenev, 1934: 367 - 388); Tashkent Province: Tashkent (Olenev, 1934: 367 - 388; Pomerantzev, 1950: 128 - 131), on cattle (Shternogold and Getzonok, 1938: 12 pp.); Andizhan Province: Andizhan; Fergana Province: Kokand; Surkhan - Darinskaya Province: Sherabad; Termez (Pomerantzev, 1950: 128 - 131).

Adzharskaya A. S. S. R. - Batumi (Olenev, 1931: 3 - 125). Crimean A. S. S. R. - (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131; Olenev, 1929: 305 - 314), on cattle (Kurchatov, 1935: 115 - 123; Kurchatov and Sokolov, 1940: 35; Olenev, 1928: 84 - 96; Olenev, 1929: 43 - 48), domestic animals (Kurchatov, 1940: 32; Melnikova, 1953: 422 - 434), sheep (Olenev, 1928: 84 - 96). Daghestan A. S. S. R. - (Pomerantzev,

1946: 1 - 28; Pomerantzev, 1950: 128 - 131), on horses, goats, camels (Zolotarev, 1934; 217 - 227), cattle (Zolotarev, 1934: 217 - 227; Kurchatov, 1935: 115 - 123); Baba-iurt, on cattle; Khasavyurt, on cattle; Buynaksk, on cattle; Derbent, on horse (Olenev and Kastrov, 1932: 28 - 30). Stavropol Territory - on cattle (Kurchatov, 1940: 26 - 29; Nikolsky, 1948: 29 - 33); Mineral'nyye Vody, on cattle (Olenev and Kastrov, 1932: 28 - 30); Stavropol (Olenev, 1934: 367 - 388).

Caucasia - (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev, 1929: 305 - 314; Yakimov, 1929: 311 - 321; Yakimov, 1929: 620; Neumann, 1911: 48), on cattle (Yakimov, et al., 1926: 224 - 258; Olenev, 1929: 43 - 48: Olenev, 1928: 84 - 96; Yakimov, et al., 1928: 644 - 646; Yakimov, et al., 1929: 137 - 152; Yakimov and Rastegaeva, 1928: 514 - 521; Yakimov and Rastegaeva, 1929: 69 - 73), sheep (Olenev, 1928: 84 - 96); northern part (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131), on cattle (Kurchatov, 1935: 115 - 123; Zasukhin, 1935: 261 - 264; Zakharov, 1926: 53 - 59), horse, sheep (Zasukhin, 1935: 261 - 264), buffalo (Zakharov, 1926: 53 - 59); western part of North Caucasus (Markov and Bogoroditzsky, 1935: 110 - 114); Prikumsky District (Olenev, 1934: 367 - 388), on cattle (Olenev and Kastrov, 1932: 28 - 30); Aksai, on cattle; Podotnia village, Shelkovsky District, on cattle; Kherson village, Shelkovsky District, on cattle (Olenev and Kastrov, 1932: 28 - 30).

Central Asia - (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139), on cattle (Shternogold and Getzonok, 1938: 12 pp.; Olenev, 1929: 43 - 48).

Transcaucasia - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131), on cattle (Kurchatov, 1935: 115 - 123; Pomerantzev and Matikashvili, 1940: 100 - 133), horse, buffalo, sheep, goat, camel, dog (Pomerantzev and Matikashvili, 1940: 100 - 133).

Turkestan - (Olenev, 1934: 367 - 388; Olenev, 1929: 305 - 314), on cattle (Yakimov, et al., 1926: 224 - 258; Olenev, 1928: 84 - 96; Yakimov, 1917: 298 - 301), sheep (Olenev, 1928: 84 - 96), camel (Yakimov, 1917: 298 - 301).

On following hosts without definite indication of locality: cattle, sheep, goat, horse (Olenev, 1931: 3 - 125; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131), buffalo, camel, dog, deer (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131).

Biology

Life history: Oviposition began 4 to 9 days after the female

dropped from the host (Markov and Bogoroditzsky, 1935: 110 - 114). The preferred sites of oviposition were low lying marshy areas, water meadows and the edges of irrigation ditches (Galuzo, 1941: 51 - 55). In the laboratory optimum conditions were 30° C. and about 100% relative humidity, but at 18° C. the preoviposition and the oviposition periods were prolonged and the number of eggs deposited and the percentage that hatched were reduced. A lower humidity at either temperature resulted in a dessication of the eggs. The presence or the absence of light had little effect on oviposition (Shternogold and Getzonok, 1938: 12 pp.).

Larvae hatched from the eggs in 28 to 30 days and this stage lasted 7 to 8 days (Markov and Bogoroditzsky, 1935: 110 - 114). The autumn larvae usually overwintered (Galuzo, 1943: 50 - 68) in meadow steppes, grassy waste lands and non-irrigated lucerne fields (Galuzo, 1941: 51 - 55). The nymphal stage also lasted 7 to 8 days and engorged females occurred 7 to 8 days later. The cycle from egg to adult was completed in approximately two months (Markov and Bogoroditzsky, 1935: 110 - 114) on one host (Galuzo, 1943: 50 - 68; Pomerantzev, 1950: 128 - 131; Alfeev, 1951: 398 - 403).

Hosts of stages: Adult - cattle (Mlinac and Oswald, 1937: 277 - 297; Cernaianu, 1935: 281 - 293; Matikashvili, 1936: 237 - 249; Olenev, 1930: 604 - 610; Kurchatov, 1935: 115 - 123; Tzelishcheva, 1941: 34 - 36; Tzelishcehva, 1941: 63 - 64; Yakimov and Vasilevskaya, 1926: 192 - 210; Yakimov and Vasilevskaya, 1924: 52 - 64; Olenev and Kastrov, 1932: 28 - 30; Pospelova-Shtrom, 1935: 135 - 148; Galuzo, et al., 1935: 167 - 185, Pavlovsky, et al., 1941: 48 - 50; Galuzo, 1943: 50 - 68; Galuzo, 1943: 97 - 105; Galuzo and Bespalov, 1935: 199 - 204; Shternogold and Getzonok, 1938: 12 pp.; Lototsky and Pokrovsky, 1946: 64 - 74; Kurchatov and Sokolov, 1940: 35; Olenev, 1929: 43 - 48; Olenev, 1928: 84 - 96; Zolotarev, 1934: 217 - 227; Kurchatov, 1940: 26 - 29; Nikolsky, 1948: 29 - 33; Yakimov, et al., 1928: 644 - 646; Yakimov, et al., 1929: 137 - 152; Yakimov and Rastegaeva, 1928: 514 - 521; Yakimov and Rastegaeva, 1929: 69 - 73; Zasukhin, 1935: 261 - 264; Yakimov, et al., 1926: 224 - 258; Zakharov, 1926: 53 - 59; Pomerantzev and Matikashvili, 1940: 100 - 133; Yakimov, 1917: 298 - 301; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131), horses (Knuth, et al., 1918: 241 - 264; Olenev and Kastrov, 1932: 28 - 30; Pospelova-Shtrom, 1935: 135 - 148; Galuzo, 1943: 50 - 68; Zolotarev, 1934: 217 - 227; Zasukhin, 1935: 261 - 264; Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131), zebu (Yakimov, et al., 1934: 235 - 254), domestic animals (Galuzo, 1941: 51 - 55; Pospelova-Shtrom, 1935: 135 - 148;

Galuzo, 1943: 50 - 68; Pavlovsky, 1945: 65 - 92; Kurchatov, 1940: 32; Melnikova, 1953: 422 - 434), sheep (Pospelova-Shtrom, 1935: 135 - 148; Olenev, 1928: 84 - 96; Zasukhin, 1935: 261 - 264; Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131), goats (Pospelova-Shtrom, 1935: 135 - 148; Zolotarev, 1934: 217 - 227; Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131), wild animals (Pospelova-Shtrom, 1935: 135 - 148), Cervus affinis bactrianus, Ovis vignei bokhariensis (Pospelova-Shtrom, 1935: 115 - 134), camels (Zolotarev, 1934: 217 - 227; Pomerantzev and Matikashvili, 1940: 100 - 133; Yakimov, 1917: 298 - 301; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131); buffalo (Zakharov, 1926: 53 - 59; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131), dog (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131), deer (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 128 - 131).

Nymph - horses (Knuth, et al., 1918: 241 - 264; Zasukhin, 1935: 261 - 264; Pomerantzev and Matikashvili, 1940: 100 - 133), domestic animals (Galuzo, 1941: 51 - 55; Kurchatov, 1940: 32), cattle (Lototsky and Pokrovsky, 1946: 64 - 74; Zasukhin, 1935: 261 - 264; Pomerantzev and Matikashvili, 1940: 100 - 133), sheep (Zasukhin, 1935: 261 - 264; Pomerantzev and Matikashvili, 1940: 100 - 133), buffalo, goat (Pomerantzev and Matikashvili, 1940: 100 - 133).

Larva - domestic animals (Galuzo, 1941: 51 - 55; Kurchatov, 1940: 32); cattle (Lototsky and Pokrovsky, 1946: 64 - 74; Zasukhin, 1935: 261 - 264; Pomerantzev and Matikashvili, 1940: 100 - 133), horse, sheep (Zasukhin, 1935: 261 - 264; Pomerantzev and Matikashvili, 1940: 100 - 133), buffalo, goat (Pomerantzev and Matikashvili, 1940: 100 - 133).

Seasonal activity: In the northern part of Caucasus B. calcaratus appeared at the end of March or early in April and disappeared in September or in October (Yakimov, et al., 1929: 137 - 152; Markov and Bogoroditzsky, 1935: 110 - 114).

In Tadzhik all stages occurred simultaneously on domestic animals (Lototsky and Pokrovsky, 1946: 64 - 74) during the entire warm season (Pospelova-Shtrom, 1935: 135 - 148). They were present from mid-February to the end of November and showed three waves of infestation: the first extended from mid-April to about June, the second started in June and reached a peak in August and the third overlapped the second and lasted till mid-October (Lototsky and Pokrovsky, 1946: 64 - 74).

In Transcaucasia the adults were active the entire year and showed 2 maximum peaks: one peak was in June-July and the other was in August-September. The nymphs were present from May to December and the larvae occurred in April, July, August and September (Pomerantzev and Matikashvili, 1940: 100 - 133).

Habitats: All stages of H. calcaratus occurred in the steppe zone (Olenev, 1931: 3 - 125), semi-steppe zone (Kurchatov, 1935: 115 - 123; Pomerantzev and Matikashvili, 1940: 100 - 133), semi-desert zone (Olenev, 1931: 3 - 125; Zasukhin, 1935: 1 - 159), lowland pastures (Pospelova-Shtrom, 1935: 135 - 148), lowland forests (Pomerantzev and Matikashvili, 1940: 100 - 133), forest zone (Olenev, 1931: 3 - 125; Kurchatov, 1935: 115 - 123; Pomerantzev and Matikashvili, 1940: 100 - 133; Melnikova, 1953: 422 - 434), semi-forest areas, areas covered with brushwood (Kurchatov, 1935: 115 - 123), mountain steppes (Pomerantzev and Matikashvili, 1940: 100 - 133), forest steppe areas in river valleys (Kurchatov, 1940: 32), meadow steppes, low lying marshy areas and water meadows (Galuzo, 1941: 51 - 55).

Control Measures

Agricultural practices such as mowing, disking and harrowing of fields, rotating grazing pastures, cleanliness of farm buildings and chemical treatment of infested animals were recommended for reducing the tick population (Pavlovsky, et al., 1941: 48 - 50; Galuzo, 1943: 50 - 68).

Satisfactory results were achieved with the use of 0.18 - 0.2% solution of sodium arsenite applied by brush and spray at intervals of six days (Lototsky and Pokrovsky, 1946: 64 - 74). Cattle dipped at intervals of 5 days in an arsenical solution containing 0.16% As_2O_3 were completely freed of ticks after the third treatment (Kurchatov, 1940: 26 - 29). Good results were obtained in experiments with used lubricating oil, either alone or emulsified with clay or ox bile (Bernadskaya, 1944: 44).

Larvae which were heavily dusted with DDT were incapable of movement in 5 hours and those dusted with BHC became so in 3 hours. When immersed for 1 minute in 0.01 - 0.5% suspensions all larvae were immobilized in 60 seconds by 0.1 or 0.5% BHC but 10 - 13% survived the 0.01% suspension. The larvae were affected by all concentrations of DDT. A 0.1% suspension of BHC on the skin of the host remained toxic to larvae for 14 - 19 days. A 0.01% suspension of BHC killed newly moulted adults but did not affect those which

were already feeding and some of these surviving females laid viable eggs. A 0.1% suspension of BHC applied to cattle killed the larvae but did not kill nymphs or adults. A 0.5% suspension applied twice at intervals of 5 days was very effective against all stages (Nikolsky, 1948: 29 - 33).

Relation to Disease

Piroplasmosis: B. calcaratus was found to be a natural and experimental vector to cattle of Babesia bigemina (Yakimov, 1922: 41 - 46; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 128 - 131; Cernaianu, 1937: 281 - 293; Zasukhin, 1935: 261 - 264; Galuzo and Bespalov, 1935: 199 - 204; Yakimov and Vasilevskaya, 1924: 52 - 64; Yakimov and Vasilevskaya, 1926: 192 - 210; Yakimov, et al., 1929: 137 - 152; Yakimov, 1929: 311 - 321), Francaiella colchica (Matikashvili, 1936: 237 - 249; Pomerantzev and Matikashvili, 1940: 100 - 133; Chizh, 1941: 58 - 60; Pomerantzev, 1950: 128 - 131; Zasukhin, 1935: 261 - 264; Galuzo and Bespalov, 1935: 199 - 294; Yakimov and Rastegaeva, 1928: 514 - 521; Yakimov and Rastegaeva, 1929: 69 - 73; Yakimov, et al., 1929: 137 - 152), Theileria annulata (Yakimov, 1922: 41 - 46).

Anaplasmosis: It was regarded as a vector of Anaplasma rossicum (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 128 - 131; Yakimov, et al., 1929: 137 - 152) and Anaplasma marginale (Zasukhin, 1935: 261 - 264).

Spirochaetosis: B. calcaratus transmitted Spirochaeta theileri (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 128 - 131; Yakimov, et al., 1929: 137 - 152; Yakimov, 1929: 98 - 101; Olenev, 1931: 3 - 125).

Tick paralysis: An extract prepared from eggs of B. calcaratus produced tick paralysis when injected into guinea pigs (Mlinac and Oswald, 1937: 277 - 297).

Dermacentor antrorum Reznik

Dermacentor antrorum Reznik, 1950: 112 - 114.

The description was based upon 2 males, 1 female and 4 nymphs taken off Microtus arvalis and Chionomys nivalis in Kzyl-Kotch, Armenian S. S. R. The type was deposited in the Stavropol Laboratory of the Institute of Malaria and Medical Parasitology of the Academy

of Medical Sciences (Reznik, 1950: 112 - 114).

Dermacentor marginatus (Sulz.)

Acarus marginata Sulzer, 1776: 245.

Dermacentor marginatus, Olenev, 1931: 126 - 139; Olenev and Kastrov, 1932: 28 - 30; Schulze, 1933: 416, 423 - 424; Olenev, 1934: 672 - 674; Zolotarev, 1934: 217 - 227; Kurchatov and Kalmikov, 1934: 80 pp.; Olenev, 1934: 367 - 388; Zasukhin, 1935: 1 - 159; Markov, et al., 1935: 106 - 109; Zasukhin, 1935: 261 - 264; Schulze, 1935: 178 - 186; Alfeev, 1935: 65 - 87; Kochetkov, 1935: 124 - 127; Zasukhin, 1936: 219 - 226; Shmulevich, et al., 1940: 34; Pomerantzev and Matikashvili, 1940: 100 - 133; Kurchatov and Sokolov, 1940: 35; Kurchatov, 1940: 32; Serdyukova, 1941: 135 - 144; Markov, 1941: 7 - 9; Galuzo, 1941: 51 - 55; Kurchatov, 1941: 97 - 103; Khatenever, 1942: 82 - 86; Galuzo, et al., 1944: 123 - 137; Galuzo, 1944: 132; Karpov and Popov, 1944: 75 - 79; Demidov, et al., 1944: 22; Pomerantzev, 1946: 17, 18; Ishukov and Ishukova, 1946: 51 - 63; Grobov, 1946: 59 - 63; Vasiliev, 1947: 5 - 9; Pletzity, 1947: 877 - 878; Alfeev, 1948: 50 - 60; Pavlovsky, 1948: 586 - 587; Nikolsky, 1948: 29 - 33; Fedyushin, 1949: 485 - 494; Orlov, 1949: 337 - 364; Lototsky, 1949: 389 - 392; Pomerantzev, 1950: 149 - 155; Reznik, 1950: 327 - 328; Shatas, 1952: 802 - 818; Pokrovskaya, 1953: 435 - 440; Chernina, 1953: 58 - 61; Melnikova, 1953: 422 - 434.

Dermacentor reticulatus, Neumann, 1897: 363, in part; Neumann, 1911: 99 - 100, in part; Pomerantzev, 1950: 149 - 155.

Dermacentor silvarum, Olenev, 1931: 84 - 85, in part; Schulze, 1935: 178 - 186; Pomerantzev, 1950: 149 - 155.

Not Dermacentor marginatus, Olenev, 1931: 3 - 125; Alfeev, 1939: 99 - 109 (= D. pictus acc. Pomerantzev, 1950: 149 - 155).

Localities and Hosts

Europe

Europe - (Olenev, 1931: 126 - 139); southern part and islands of Mediterranean Sea (Pomerantzev, 1946: 17 - 18; Pomerantzev, 1950: 149 - 155). France - (Olenev, 1934: 367 - 388). Germany - (Olenev,

1934: 367 - 388). Great Britain - (Olenev, 1934: 367 - 388). Poland - Slonim District, south of Vilno (Olenev, 1934: 367 - 388).

U. S. S. R.

U. S. S. R. - (Olenev, 1931: 126 - 139; Kurchatov and Kalmikov, 1934: 80 pp.); western desert, on horse (Olenev, 1934: 367 - 388). Armenian S. S. R. - (Pomerantzev and Matikashvili, 1940: 100 - 133). Azerbaijan S. S. R. - (Pomerantzev and Matikashvili, 1940: 100 - 133), on domestic animals (Kurchatov, 1941: 97 - 103). Byelorussian S. S. R. - Vitebsk Province: Vitebsk; Armbrosovitchi (Olenev, 1934: 367 - 388). Kazakh S. S. R. - (Pomerantzev, 1946: 17 - 18; Pomerantzev, 1950: 149 - 155), on horses (Galuzo, 1944: 132), domestic animals (Galuzo, 1941: 51 - 55; southern part, on cattle, sheep (Galuzo, et al., 1944: 123 - 127). Kirghiz S. S. R. - (Pomerantzev, 1950: 149 - 155). Tadzhik S. S. R. - (Lototsky, 1949: 389 - 392); upper part (Pomerantzev, 1950: 149 - 155). Ukrainian S. S. R. - (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 149 - 155). Uzbek S. S. R. - (Pomerantzev, 1950: 149 - 155).

R. S. F. S. R. - Astrakhan Province (Shatas, 1952: 802 - 818); Kaluga Province: Zhizdra, on horse (Olenev, 1934: 367 - 388); Moscow Province: Kadom District, on horse (Shmulevich, et al., 1940: 34); Omsk Province: on cattle, rodents (Fedyushin, 1949: 485 - 494); Rostov Province (Pomerantzev, 1946: 17, 18); Saratov Province: Saratov, Viazovsk, on dog, horse (Zasukhin, 1935: 1 - 159); Stalingrad Province: on cattle, horse, sheep, rodents, small carnivores, hedgehog, cat, Cricetus cricetus, Arvicola terrestris, Apodemus sylvaticus, Apodemus flavicollis, Microtus arvalis, Dyromys nitedula, Clethrionomys glareolus, Lepus europaeus, water rat (Shatas, 1952: 802 - 818); Voronezh Province: on man, cattle (Pokrovskaya, 1953: 435 - 440). Velikiye Luki Province: Sebezh, on horse (Olenev, 1934: 367 - 388).

Abkhazskaya A. S. S. R. - Sukhumi (Pomerantzev and Matikashvili, 1940: 100 - 133). Bashkirskaya, A. S. S. R. - on horse (Ishukov and Ishukova, 1946: 51 - 63). Crimean A. S. S. R. - (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 149 - 155), on horse (Kurchatov and Sokolov, 1940: 35), cattle (Melnikova, 1953: 422 - 434; Kurchatov, 1940: 32), domestic animals (Kurchatov, 1940: 32), hare, deer, moufflon, fox, squirrel (Melnikova, 1953: 422 - 434); Kerch Peninsula (Grobov, 1946: 59 - 63). Daghestan A. S. S. R. - on cattle, horse, sheep, dog (Zolotarev, 1934: 217 - 227); Buinak, on cattle (Olenev and Kastrov, 1932: 28 - 30). Stavropol Territory - (Reznik, 1950: 327 - 328), on cattle (Nikolsky, 1948: 29 - 33). Caucasia - (Pomerantzev,

1946: 17, 18; Pomerantzev, 1950: 149 - 155); northern part, on horse (Demidov, et al., 1944: 22). Siberia - southern and eastern parts of western Siberia (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 149 - 155). Transcaucasia - (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 149 - 155); central, eastern, and southern parts, on cattle, sheep, goat, buffalo, horse, donkey, swine, dog, hare, hedgehog, small rodents, Apodemus sylvaticus (Pomerantzev and Matikashvili, 1940: 100 - 133). Transural Region - on horse, cattle, sheep, dog (Kochetkov, 1935: 124 - 127); southern part on horse (Vasiliev, 1947: 5 - 9). Volga Region - middle and lower part (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 149 - 155). Don Provinces - (Pomerantzev, 1950: 149 - 155).

On following hosts without definite indication of locality: domestic animals (Pomerantzev, 1946: 17, 18), hare, hedgehog, Insectivora, rodents, small carnivores (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 149 - 155), cattle sheep, goat, buffalo, horse, donkey, swine, camel, wolf, dog, man; Lagurus lagurus, Mustela nivalis, Putorius eversmanni, Microtus arvalis, Alactaga jaculus, Erinaceus rumanicus, Citellus suslica, Cricetus cricetus, Sorex araneus, Apodemus sylvaticus, Lepus europaeus, Apodemus agrarius, Neomys fodiens, Vulpes vulpes, Clethrionomys glareolus, Rattus norvegicus, Sicista nordmanni, Spalax microphthalmus, Arvicola terrestris (Pomerantzev, 1950: 149 - 155).

Biology

Life history: No information was found concerning this species.

Hosts of stages: Adult - horse (Olenev, 1934: 367 - 388; Galuzo, 1944: 132; Shmulevich, et al., 1940: 34; Zasukhin, 1935: 1 - 159; Shatas, 1952: 802 - 818; Ishukov and Ishukova, 1946: 51 - 63; Kurchatov and Sokolov, 1940: 35; Zolotarev, 1934: 217 - 227; Demidov, et al., 1944: 22; Pomerantzev and Matikashvili, 1940: 100 - 133; Kochetkov, 1935: 124 - 127; Vasiliev, 1947: 5 - 9; Pomerantzev, 1950: 149 - 155), domestic animals (Kurchatov, 1941: 97 - 103; Galuzo, 1941: 51 - 55; Kurchatov, 1940: 32; Pomerantzev, 1946: 17, 18), cattle (Galuzo, et al., 1944: 123 - 127; Fedyushin, 1949: 485 - 494; Shatas, 1952: 802 - 818; Pokrovskaya, 1953: 435 - 440; Kurchatov, 1940: 32; Melnikova, 1953: 422 - 434; Olenev and Kastrov, 1932: 28 - 30; Zolotarev, 1934: 217 - 227; Nikolsky, 1948: 29 - 33; Pomerantzev and Matikashvili, 1940: 100 - 133; Kochetkov, 1935: 124 - 127; Pomerantzev, 1950: 149 - 155), sheep (Galuzo, et al., 1944: 123 - 127; Shatas, 1952: 802 - 818; Zolotarev, 1934: 217 - 227; Pomerantzev and Matikashvili,

1940: 100 - 133; Kochetkov, 1935: 124 - 127; Pomerantzev, 1950: 149 - 155), dog (Zasukhin, 1935: 1 - 159; Zolotarev, 1934: 217 - 227; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 149 - 155; Kochetkov, 1935: 124 - 127), man (Pokrovskaya, 1953: 435 - 440; Pomerantzev, 1950: 149 - 155), deer, moufflon (Melnikova, 1953: 422 - 434), hare (Melnikova, 1953: 422 - 434; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 149 - 155), goat, buffalo, donkey, swine, (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 149 - 155), hedgehog (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 149 - 155), camel, wolf (Pomerantzev, 1950: 149 - 155).

Nymph and larva - rodents (Fedyushin, 1949: 485 - 494; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 149 - 155), small carnivores (Shatas, 1952: 802 - 818; Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 149 - 155), hedgehog, cat (Shatas, 1952: 802 - 818), Cricetus cricetus (Shatas, 1952: 802 - 818; Pomerantzev, 1950: 149 - 155), Arvicola terrestris (Shatas, 1952: 802 - 818; Pomerantzev, 1950: 149 - 155), Apodemus sylvaticus (Shatas, 1952: 802 - 818; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 149 - 155), Apodemus flavicollis, Dyromys nitedula, water rat (Shatas, 1952: 802 - 818), Microtus arvalis, Clethrionomys glareolus, Lepus europaeus (Shatas, 1952: 802 - 818; Pomerantzev, 1950: 149 - 155), Vulpes vulpes (Melnikova, 1953: 422 - 434; Pomerantzev, 1950: 149 - 155), insectivores (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 149 - 155), squirrel (Melnikova, 1953: 422 - 434), Lagurus lagurus, Mustela nivalis, Putorius eversmanni, Alactaga jaculus, Erinaceus rumanicus, Citellus suslica, Sorex araneus, Apodemus agrarius, Neomys fodiens, Rattus norvegicus, Sicista nordmanni, Spalax microphthalmus (Pomerantzev, 1950: 149 - 155).

Seasonal activity: In Crimea the adults were active in the spring months (April-May) and in the autumn months (October-December) but were not present in the summer. The larvae and nymphs were present from June to August with a maximum abundance at the end of July (Melnikova, 1953: 422 - 434; Kurchatov, 1940: 32).

In Transcaucasia the adults were active the entire year and showed two peaks of activity, the first from February to March and the second from August to November (Pomerantzev and Matikashvili, 1940: 100 - 133).

In the central Transural Region the adults occurred from early spring to the end of June and appeared again in August to the end of October (Kochetkov, 1935: 124 - 127).

In Stalingrad Province the adults were active from April-May and appeared again in the second half of August. The larvae and nymphs showed maximum abundance in June and July (Shatas, 1952: 802 - 818). In Voronezh Province the maximum density of adults was observed at the end of April and in late May (Pokrovskaya, 1953: 435 - 440).

Habitats: All stages of D. marginatus were found in the forest steppe regions (Pokrovskaya, 1953: 435 - 440; Fedyushin, 1949: 485 - 494; Zasukhin, 1935: 1 - 159), in the steppe regions (Pokrovskaya, 1953: 435 - 440; Pomerantzev, 1950: 149 - 155), in deciduous forests (Kochetkov, 1935: 124 - 127; Olenev, 1931: 126 - 139; Pomerantzev and Matikashvili, 1940: 100 - 133) in deserts, in semi-deserts and in mountain steppes (Pomerantzev and Matikashvili, 1940: 100 - 133).

Control Measures

Agricultural methods designed to destroy eggs and engorged larvae and nymphs in pastures included mowing and removal of hay, plowing of strips along the roads and fields, removing dense growths of weeds near irrigation ditches and the sowing of fodder grasses in pasture. Other recommended practices were cleanliness of stables and yards, destruction of small rodents serving as hosts and transportation for ticks, and the protection of horses from infestation by keeping them from places where ticks congregate. All these measures should be supplemented by chemical treatment of infested animals (Galuzo, 1944: 132).

Ointments made from pyrethrum powder and vaseline or similar substances were found to be particularly effective in killing practically all the starved and partially engorged adults (Kurchatov, 1941: 97 - 103). Larvae heavily dusted with a 5% concentration of DDT became incapable of movement in 5 hours while those dusted with BHC were immobilized in 3 hours. When immersed for 1 minute in 0.01 - 0.5% suspension of BHC all larvae were immobilized in 60 minutes by the 0.1 or 0.5% BHC but 10 - 13% survived when treated with a 0.01% suspension. Larvae were affected by all concentrations of DDT. The BHC and DDT dusts killed all adults but the 0.1% BHC did not prevent females from depositing viable eggs. A 0.5% suspension of BHC killed adults and when applied 3 times at 5 day intervals freed calves from a heavy infestation (Nikolsky, 1948: 29 - 33).

Experiments were carried out near Omsk in the forest steppe zone to ascertain the effect of pasture improvement on D. margina-

tus. The improved pastures were maintained for about five years in a program of crop rotation and they were established by sowing grass on plowed land which was harrowed periodically. Though ticks still occurred in these improved pastures they were far less numerous than in the natural pastures. The number of rodents present and the percentage of them infested by larvae and nymphs were also smaller in the improved pastures. When the ticks were exposed on a plot that had been plowed and was devoid of vegetation the winter mortality was complete and dead ticks were found in the upper two inches of the soil. The survival of unfed ticks after plowing was found to be in inverse proportion to the plowing depth and to the humidity of the soil (Fedyushin, 1949: 485 - 494).

Relation to Disease

Tularemia: Nymphs and adults were found naturally infected with Bacterium tularense (Khatenever, 1942: 82 - 86) and transmitted tularemia to man and domestic animals (Pomerantzev, 1950: 149 - 155; Pokrovskaya, 1953: 435 - 440). In laboratory experiments it was found that if larvae were infected with tularemia they eliminated infective excrements in all subsequent developmental stages. The bacteria survived for 7 days in the excrements of adults under unfavorable conditions (20 - 24° C., low humidity). When infected excrements were placed in open scars on the belly of a healthy mouse it became infected with tularemia. When D. marginatus was infected in the larval stage it passed the bacteria to the subsequent stages. These infected nymphs and adults when fed on guinea pigs caused a lethal tularemia infection. However, in only 1 out of 6 experiments were infected ova obtained. Humans acquired tularemia from handling infected animals or from the fur of infected animals polluted by tick excrements (Chernina, 1953: 58 - 61).

Tick-borne Typhus: D. marginatus was reported to be a vector of this disease (Pomerantzev, 1950: 149 - 154; Pokrovskaya, 1953: 435 - 440) and several strains of rickettsiae were isolated from it (Pletzity, 1947: 877 - 878).

Relapsing Fever: D. marginatus did not retain the spirochaetes of the Stalinabad strain of relapsing fever for more than 24 hours when infected experimentally (Serdyukova, 1941: 135 - 144).

Plague: This species was regarded as a vector to man and to domestic animals (Pomerantzev, 1950: 149 - 155).

Spring-Summer Encephalitis and Japanese-B Encephalitis: D. marginatus was regarded as a vector of these diseases (Pokrovskaya,

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1953: 435 - 440).

Brucellosis: Brucella abortus in cattle was inaccessible to ticks owing to its position in the body of the hosts and could not, therefore, be acquired by them, but B. melitensis was ingested by specimens of D. marginatus that fed on infected sheep and was transmitted to other animals through the bites of subsequent stages (Galuzo, et al., 1944: 123 - 137; Pomerantzev, 1950: 149 - 154).

Equine Encephalo-Myelitis: D. marginatus was experimentally infected with the virus causing this disease and it preserved the virus for a considerable period of time. The virus was also found in ticks collected fron infected horses or from localities in which the disease occurred (Ishukov and Ishukova, 1946: 51 - 63). When fluid extracted from ticks that had fed on a diseased horse was injected into 2 guinea pigs and a rabbit they died of the disease. Fatal infection was also transmitted to a guinea pig by rubbing tick fluid into the scarified skin on its back (Vasiliev, 1947: 5 - 9).

Piroplasmosis: D. marginatus transmitted Babesia caballi to horses (Zasukhin, 1935: 1 - 159; Shmulevich, et al., 1940: 34; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 149 - 155) and in experiments it was found that B. caballi persisted in this species through three generations reared on immune hosts (Markov, 1941: 7 - 9). It also transmitted Babesia equi (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 149 - 155) and B. minor to horses (Pomerantzev, 1950: 149 - 155). It was found to be a vector of Babesia to sheep (Pomerantzev, 1950: 149 - 155) and it was a suspected vector of B. canis to dogs (Pomerantzev, 1950: 149 - 155; Zasukhin, 1935: 261 - 264).

Anaplasmosis: D. marginatus transmitted Anaplasma to sheep (Pomerantzev, 1950: 149 - 155) and various haemosporidians to cattle (Pokrovskaya, 1953: 435 - 440).

Dermacentor niveus Neumann

Dermacentor reticulatus var. niveus Neumann, 1897: 365.
Dermacentor reticulatus niveus, Neumann, 1911: 100.
Dermacentor niveus, Olenev, 1927: 219 - 224; Olenev, 1927: 451 - 454; Popov, 1928: 15 - 18; Olenev, 1928: 84 - 96; Olenev, 1928: 35 - 39; Olenev, 1929: 305 - 314; Olenev, 1929: 25 pp.; Olenev, 1930: 604 - 610; Olenev, 1931: 3 - 125; Zasukhin, 1931: 275 - 282; Olenev, 1931: 126 - 139; Olenev, 1931: 281 - 284; Zasukhin,

1932: 181 - 185; Olenev and Kastrov, 1932: 28 - 30; Kolpakova and Lippert, 1932: 191 - 195; Zasukhin, 1933: 277 - 282; Zasukhin, 1933: 31 - 46; Schulze, 1933: 416; Olenev and Rozhdestvenskaya, 1933: 478 - 479; Zasukhin and Tiflov, 1933: 437 - 442; Zolotarev, 1934: 217 - 227; Kurchatov and Kalmikov, 1934: 80 pp.; Yakimov, et al., 1934: 235 - 254; Lototzky and Popov, 1934: 67 - 80; Zasukhin, 1935: 1 - 159; Galuzo, et al., 1935: 167 - 185; Zasukhin, 1935: 261 - 264; Pospelova-Shtrom , 1935: 115 - 134; Schulze, 1935: 178 - 186; Zasukhin, 1936: 155 - 164; Zasukhin, 1936: 219 - 226; Blagoveshchensky, 1937: 16 - 38; Agriinsky, 1938: 1 - 9; Karpov and Popov, 1944: 75 - 79; Demidov, et al., 1944: 22; Pomerantzev, 1946: 16, 18.

Dermacentor niveus var. daghestanicus Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125.

Dermacentor daghestanicus, Schulze, 1935: 178 - 186; Pomerantzev, 1946: 16, 18; Lototzky, 1949: 389 - 392; Lototzky, 1949: 276 - 286; Pomerantzev, 1950: 155 - 159.

Localities and Hosts

Asia

Iran - (Olenev, 1927: 451 - 454), on Ovis aries and Camelus bactrianus (Neumann, 1911: 100). Mongolia - southern part (Pomerantzev, 1946: 16, 18; Pomerantzev, 1950: 155 - 159).

U. S. S. R.

U. S. S. R. - (Kurchatov and Kalmikov, 1934: 80 pp.); European and Asiatic parts (Olenev, 1929: 305 - 314), on horse, cattle, sheep, man (Olenev, 1928: 84 - 96). Armenian S. S. R. - on pigs (Lototzky and Popov, 1934: 67 - 80). Azerbaijan S. S. R. - on zebu (Yakimov, et al., 1934: 212 - 213).

Kazakh S. S. R. - (Olenev, 1931: 3 - 125), on domestic animals (Olenev, 1929: 25 pp.), camel, horse, cattle, sheep (Olenev, 1930: 604 - 610); southwestern and southeastern parts (Pomerantzev, 1946: 16, 18; Pomerantzev, 1950: 155 - 159); western part, on horses, cattle, camels (Zasukhin, 1931: 275 - 282; Kolpakova and Lippert, 1932: 191 - 195), man, Citellus pygmaeus, Marmota bobak, Cricetus species, Alactaga species (Zasuckhin, 1931: 275 - 282), sheep (Kolpakova and Lippert, 1932: 191 - 195); Lbischensk; Djangal; Slomikhin (Zasukhin, 1935: 1 - 159), on Hemiechinus auritus (Zasukhin, 1936: 219 - 226);

Guryev Province: (Zasukhin, 1933: 31 - 46), Guryev (Zasukhin, 1935: 1 - 159); Zapadno-Kazakh Province: Kalmykovo (Zasukhin, 1935: 1 - 159); Novaya Kazanka, on Hemiechinus auritus (Zasukhin, 1936: 219 - 226). Moldavian S. S. R. - (Olenev, 1927: 451 - 454).

R. S. F. S. R. - southeastern part, on horses (Zasukhin, 1932: 181 - 185; Zasukhin, 1933: 277 - 282; Zasukhin, 1935: 261 - 264), Citellus pygmaeus (Zasukhin and Tiflov, 1933: 437 - 442); Amur Province: on horses, cattle, sheep, dogs, man and small rodents (Popov, 1928: 15 - 18); Astrakhan Province: (Zasukhin, 1933: 31 - 46); Astrakhan (Zasukhin, 1935: 1 - 159); Grozny Province: Kizlyar (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314); Talovka, on cattle (Olenev and Kastrov, 1932: 28 - 30); Kemerovo Province (Karpov and Popov, 1944: 75 - 79); Novosibirsk Province (Karpov and Popov, 1944: 75 - 79); Saratov Province: on horses (Olenev, 1928: 35 - 39); Novouzensk; Ozink; Balashov; Pugachev; Romanovka; Saratov; Samoylovka (Zasukhin, 1935: 1 - 159); vicinity of Saratov, on Erinaceus rumanicus (Zasukhin, 1936: 219 - 226; Zasukhin, 1936: 155 - 164); vicinity of Ekaterinovka, on Erinaceus rumanicus (Zasukhin, 1936: 219 - 226); Stalingrad Province: Uryupinsk; Dubovka; Kalachevsk (Zasukhin, 1935: 1 - 159).

Tadzhik S. S. R. - (Lototzky, 1949: 389 - 392; Pomerantzev, 1950: 155 - 159), on Lepus tolai bokhariensis (Pospelova-Shtrom, 1935: 115 - 134); Gissar Valley (Galuzo, et al., 1935: 167 - 185). Turkmen S. S. R. - Ashkhabad Province: Krasnovodsk (Pomerantzev, 1946: 16, 18; Pomerantzev, 1950: 155 - 159). Uzbekh S. S. R. - Tashkent, on horses (Agriinsky, 1938: 1 - 9).

Crimean A. S. S. R. - (Olenev, 1927: 451 - 454). Daghestan A. S. S. R. - (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314), on cattle, horses, camels (Zolotarev, 1934: 217 - 227); eastern part (Pomerantzev, 1946: 16, 18; Pomerantzev, 1950: 155 - 159). Karakalpakskaya A. S. S. R. - (Pomerantzev, 1946: 16, 18; Pomerantzev, 1950: 155 - 159).

Caucasia - (Olenev, 1929: 305 - 314); northern part, on horses (Demidov, et al., 1944: 22); eastern part of north Caucasus: Prikumsky district, on cattle (Olenev and Kastrov, 1932: 28 - 30).

Central Asia - (Olenev, 1931: 3 - 125). Lower Volga Region - Narimanovks; Ershovsk; Nehaevsk; Nijnechirsk; Kemishinsk; Mihailovsk; Ivantelvsk; Khualinsk; Olihovsk; Vorkresensk; Velsky; Lysogorsk; Tatischevsk, Ekaterinovsk (Zasukhin, 1935: 1 - 159). Siberia - eastern part (Olenev, 1927: 451 - 454), on horses and sheep (Olenev, 1927: 219 - 224); western part (Karpov and Popov, 1944: 75 - 79). Turkestan - (Olenev, 1927: 451 - 454; Olenev, 1931: 3 - 125;

Olenev and Rozhdestvenskaya, 1933: 478 - 479), on hedgehog and hamster (Pomerantzev, 1950: 155 - 159); northern part (Olenev, 1928: 35 - 39).

On following hosts without definite indication of locality: camel, horse, cattle (Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 155 - 159), donkey (Olenev, 1931: 3 - 125), sheep (Olenev, 1931: 3 - 125; Zasukhin, 1935: 1 - 159), goat (Olenev, 1931: 3 - 125), man (Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 155 - 159), domestic animals, hedgehog, mice, hamster (Pomerantzev, 1946: 16, 18), swine, Cervus bactrianus, Hemiechinus albulus, Hemiechinus albulus turanicus, Mus musculus severtzovi, Cricetus cricetus (Pomerantzev, 1950: 155 - 159).

Biology

Life history: Oviposition occurred in May at intervals varying from 2 to 19 days after feeding and the number of eggs laid varied from a few dozen up to 3000, being directly proportional to the extent of engorgement (Zasukhin, 1931: 275 - 282). The eggs hatched in from 5 to 86 days and it was found that hatching occurred sooner at higher temperatures (Popov, 1928: 15 - 18; Olenev, 1928: 35 - 39; Zasukhin, 1931: 275 - 282). Excessive humidity had no effect upon the eggs and some even hatched under water (Zasukhin, 1931: 275 - 282; Olenev, 1928: 35 - 39). However, under dry conditions they were killed in 5 to 8 days (Zasukhin, 1931: 275 - 282).

Larvae fed in the laboratory only on small rodents (Zasukhin, 1931: 275 - 282) and they completed engorgement in 2 to 5 days (Popov, 1928: 15 - 18; Olenev, 1928: 35 - 39; Sasukhin, 1931: 275 - 282). The larvae molted into nymphs in from 6 to 20 days (Popov, 1928: 15 - 18; Olenev, 1928: 35 - 39; Sasukhin, 1931: 275 - 282). The minimum period for the entire larval stage was 28 - 30 days (Olenev, 1928: 35 - 39) and the larvae survived for 30 or more days at 17 - 19° C. in a humid environment but died in 2 to 5 days in a dry one (Zasukhin, 1931: 275 - 282).

The nymphs would also feed only on small rodents (Zasukhin, 1931: 275 - 282) and they completed their feeding in 3 to 7 days (Popov, 1928: 15 - 18; Zasukhin, 1931: 275 - 282). The nymphs molted to the adult stage in 14 to 26 days (Popov, 1928: 15 - 18; Zasukhin, 1931: 275 - 282).

The adults were not ready to feed until 20 days after molting from the nymphal stage (Zasukhin, 1931: 275 - 282). At temperatures of 17 to 19.5° C. with a high relative humidity unengorged

males lived three months and unengorged females lived eight months; however, under dry conditions they died in 10 to 12 days. Hibernation occurred in the unfed condition. The males died shortly after copulating (Zasukhin, 1931: 275 - 282).

Hosts of stages: Adult - sheep (Neumann, 1911: 100; Olenev, 1928: 84 - 96; Olenev, 1930: 604 - 610; Kolpakova and Lippert, 1932: 191 - 195; Popov, 1928: 15 - 18; Olenev, 1927: 219 - 224; Olenev, 1931: 3 - 125; Zasukhin, 1935: 1 - 159), camel (Neumann, 1911: 100; Olenev, 1930: 604 - 610; Zasukhin, 1931: 275 - 282; Kolpakova and Lippert, 1932: 191 - 195; Zolotarev, 1934: 217 - 227; Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 155 - 159), horse (Olenev, 1928: 84 - 96; Olenev, 1930: 604 - 610; Zasukhin, 1931: 275 - 282; Kolpakova and Lippert, 1932: 191 - 195; Zasukhin, 1932: 181 - 185; Zasukhin, 1933: 277 - 282; Zasukhin, 1935: 261 - 264; Popov, 1928: 15 - 18; Olenev, 1928: 35 - 39; Agriinsky, 1938: 1 - 9; Zolotarev, 1934: 217 - 227; Demidov, et al., 1944: 22; Olenev, 1927: 219 - 224; Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 155 - 159), cattle (Olenev, 1928: 84 - 96; Olenev, 1930: 604 - 610; Zasukhin, 1931: 275 - 282; Kolpakova and Lippert, 1932: 191 - 195; Popov, 1928: 15 - 18; Olenev and Kastrov, 1932: 28 - 30; Zolotarev, 1934: 217 - 227; Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 155 - 159), man (Olenev, 1928: 84 - 96; Zasukhin, 1931: 275 - 282; Popov, 1928: 15 - 18; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 155 - 159), swine (Lototzky and Popov, 1934: 67 - 80; Pomerantzev, 1950: 155 - 159), zebu (Yakimov, et al., 1934: 212 - 213), domestic animals (Olenev, 1929: 25 pp.; Pomerantzev, 1946: 16, 18), Citellus pygmaeus (Zasukhin, 1931: 275 - 282; Zasukhin and Tiflov, 1933: 437 - 442); Marmota bobak (Zasukhin, 1931: 275 - 282), dog (Popov, 1928: 15 - 18), donkey, goat (Olenev, 1931: 3 - 125), hedgehog (Pomerantzev, 1946: 16, 18), Cervus bactrianus, Hemiechinus albulus (Pomerantzev, 1950: 155 - 159).

Nymph - Lepus tolai bokhariensis (Pospelova-Shtrom, 1935: 115 - 134), hedgehog and hamster (Pomerantzev, 1950: 155 - 159).

Nymph and larva - Cricetus species, Alactaga species (Zasukhin, 275 - 282), Hemiechinus auritus (Zasukhin, 1936: 219 - 226), small rodents (Popov, 1928: 15 - 18), Erinaceus rumanicus (Zasukhin, 1936: 155 - 164; Zasukhin, 1936: 219 - 226), hedgehog, mice and hamster (Pomerantzev, 1946: 16, 18).

Larva - Hemiechinus albulus turanicus, Mus musculus severtzovi, Cricetus cricetus (Pomerantzev, 1950: 155 - 159).

Seasonal activity: In Amur Province the adults appeared about

the middle of April when the snow melted. Those which had hibernated occurred in large numbers up to the end of May but isolated individuals were found up to the end of June (Popov, 1928: 15 - 18).

In western Kazakh the adults also appeared when the snow melted and were especially abundant in April. Though their numbers greatly decreased at the end of April isolated individuals, chiefly males, were found on cattle as late as June. The new adults which appeared in the second half of July were only rarely found on animals and they disappeared in the autumn when they probably hibernated. The larvae were active in mid-June while the nymphs were most abundant in the second half of the month (Zasukhin, 1931: 275 - 282).

Habitats: All stages of D. niveus were found in the desert zone (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139), in the semi-desert zone (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159) and in the forest steppe zone (Zasukhin, 1935: 1 - 159: Zasukhin, 1931: 275 - 282). They lived in dry as well as damp places and both larvae and adults were found in grassland among oak forests (Olenev, 1928: 35 - 39).

Relation to Disease

Piroplasmosis: D. niveus transmitted Babesia caballi (Pomerantzev, 1950: 155 - 159; Zasukhin, 1935: 261 - 264; Zasukhin, 1931: 275 - 282; Olenev, 1928: 35 - 39) and Babesia equi to horses (Zasukhin, 1932: 181 - 185; Zasukhin, 1933: 277 - 282; Zasukhin, 1935: 261 - 264; Pomerantzev, 1950: 155 - 159). However, in one experiment it failed to transmit B. equi whereas other species did (Agrinsky, 1928: 1 - 19). The larvae and nymphs were regarded as vectors of Babesia ninense to Erinaceus rumanicus but the picture was not completely clear (Zasukhin, 1936: 219 - 226; Zasukhin, 1936: 155 - 164).

Plague: It was regarded as a possible vector of plague (Zasukhin, 1931: 275 - 282).

Dermacentor nuttalli Olenev

Dermacentor nuttalli Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314, validates nomen nudum; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Olenev, 1934: 367 - 388; Yatzimirskaya-Krontovskaya, 1939: 114 - 118; Serdyukova and Khodakovsky, 1940: 17; Aluimov,

1940: 338 - 339; Petrova-Piontkovskaya, 1941: 12 - 13; Petrova-Piontkovskaya, 1941: 122 - 134; Svirska, 1941: 32 - 33; Korshunova, 1943: 59 - 64; Bocharova, 1943: 68 - 72; Korshunova and Petrova-Piontkovskaya, 1943: 87; Krontovskaya and Shmatikov, 1943: 65 - 68; Soliterman, 1944: 50; Baydin, 1945: 10 - 11; Marikovsky, 1945: 60 - 66; Chumakov, et al., 1945: 18 - 24; Pomerantzev, 1946: 17, 18; Petriayev, 1946: 84 - 85; Pletzity, 1947: 877 - 878; Pavlovsky, 1947: 265 - 285; Dubinin, 1948: 275 - 286; Korshunova and Arkhina, 1948: 291 - 298; Pavlovsky, 1948: 590 - 592; Korshunova and Petrova-Piontkovskaya, 1948: 243 - 250; Pomerantzev, 1950: 144 - 149; Reznik, 1950: 327 - 328; Serdyukova, 1951: 909 - 912.

Dermacentor birulai kukunoriensis Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314, validates nomen nudum.

Localities and Hosts

Asia

China - Tian-Shan mountains (Pomerantzev, 1950: 144 - 149); northern part, Suchan River (Pomerantzev, 1946: 17, 18). Mongolia - (Dubinin, 1948: 275 - 286; Serdyukova, 1951: 909 - 912); western and eastern parts (Olenev, 1931: 126 - 139); northwestern part (Olenev, 1928: 84 - 96); basin of Kobdo River; town of Kobdo; valley of Dzerge River; southern shores of Lake Hara Usa; town of Potanin (Olenev, 1929: 305 - 314); Valley of Herulen River (Olenev, 1929: 305 - 314); in vicinity of Kobdo, on camel, horse, sheep (Olenev, 1931: 3 - 125); Kobdo town and Kobdo; Herulen and Kentei Rivers up to Bain-Gol River; Alashan Desert, Ust-Kiran (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 144 - 149). Tibet - (Pomerantzev, 1950: 144 - 149); eastern part; Lake Kuku Nor (Pomerantzev, 1946: 17, 18; Olenev, 1928: 84 - 96), on River Dza-Chu, valley of Golubai River (Olenev, 1928: 84 - 96).

U. S. S. R.

U. S. S. R. - southern and eastern parts, on cattle and man (Yatzimirskaya-Krontovskaya, 1939: 114 - 118). R. S. F. S. R. - Chita Province: (Reznik, 1950: 327 - 328), on cattle, camel, horse, sheep, man, small wild animals and birds (Dubinin, 1948: 275 - 286); Ukurei, Oloviannaya, Tsugulovskiy, Datsan, Aga, Borzya, Matsiyevskaya, Chita, on Microtus species (Petriayev, 1946: 84 - 85);

Irkutsk Province: Irkutsk district (Petriayev, 1946: 84 - 85). Siberia - on Citellus eversmanni (Korshunova and Arkhina, 1948: 291 - 298); central part, on man (Soliterman, 1944: 50), on cattle (Soliterman, 1944: 50; Krontovskaya and Shmatikov, 1943: 65 - 68), Citellus eversmanni, Stenocranius (Microtus) gregalis (Krontovskaya and Shmatikov, 1943: 65 - 68). Krasnoyarsk Territory - (Pletzity, 1947: 877 - 878), on man (Korshunova, 1943: 59 - 64), marmots and field mice (Korshunova and Petrova-Piontkovskaya, 1948: 243 - 250); in Abakan steppe (Serdyukova and Khodakovsky, 1940: 17); vicinity of Upper Yenisei, on cattle, sheep, man, Citellus eversmanni and Microtus species (Petrova-Piontkovskaya, 1941: 122 - 134); Minusinsk; Beloyarskoe; Mazarka; Krasnoyarsk and Kansk (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 144 - 149). Buryat-Mogol A. S. S. R. - Kyakhta; Ulan-Ude; Tarbagatoy (Petriayev, 1946: 84 - 85). Khakassays Autonomous Province - (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 144 - 149); Bagrad District, on horse (Olenev, 1934: 367 - 388). On following hosts without definite indication of locality - horse, camel, cattle, sheep, dog, field mice, rats, marmots, hamsters, hares and cat (Pomerantzev, 1950: 144 - 149), man (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 144 - 149), domestic animals (Pomerantzev, 1946: 17, 18).

Biology

Life history: In both field and laboratory studies the cycle of development required 78 - 156 days (Dubinin, 1948: 275 - 286; Pomerantzev, 1950: 144 - 149) with an average of 81 days (Dubinin, 1948: 275 - 286). There was one generation a year (Dubinin, 1948: 275 - 286; Petrova-Piontkovskaya, 1941: 122 - 134).

Oviposition occurred 4 days after the female dropped from the host and continued for 21 days on the average. The eggs hatched in about 24 days after being laid. The larvae were ready to feed 3 to 4 days after hatching and they required 2 to 8 days to complete engorgement. Most of the engorged larvae dropped from the host and molted after 5 to 8 days. The resulting nymphs attached to new hosts 3 to 4 days after molting and became engorged in 5 to 7 days. However, a few larvae molted on the host and the resulting nymphs remained to feed. The nymphs molted into adults in 11 to 12 days at 24.2° C., in 20 to 25 days at 18.2° C. and in 51 - 73 days at 10 to 13° C. Adults completed engorgement on rabbits in 5 to 17 days and on guinea pigs in 5 to 13 days (Petrova-Piontkovskaya, 1941: 122 - 134). Most of the unfed adults passed the winter in cracks

in the soil, in dry pastures and occasionally in burrows of rodents. However, a few males overwintered on cattle and it was thought that some nymphs might also do the same (Dubinin, 1948: 275 - 286).

Hosts of stages: Adult - camel (Olenev, 1931: 3 - 125; Dubinin, 1948: 275 - 286; Pomerantzev, 1950: 144 - 149), horse (Olenev, 1931: 3 - 125; Dubinin, 1948: 275 - 286; Olenev, 1934: 367 - 388; Pomerantzev, 1950: 144 - 149), sheep (Olenev, 1931: 3 - 125; Dubinin, 1948: 275 - 286; Petrova-Piontkovskaya, 1941: 122 - 134; Pomerantzev, 1950: 144 - 149), cattle (Yatzimirskaya-Krontovskaya, 1939: 114 - 118; Dubinin, 1948: 275 - 286; Krontovskaya and Shmatikov, 1943: 65 - 68; Soliterman, 1944: 50; Petrova-Piontkovskaya, 1941: 122 - 134; Pomerantzev, 1950: 144 - 149), man (Yatzimirskaya-Krontovskaya, 1939: 114 - 118; Dubinin, 1948: 275 - 286; Petrova-Piontkovskaya, 1941: 122 - 134; Soliterman, 1944: 50; Korshunova, 1943: 59 - 64; Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 144 - 149), Citellus eversmanni (Korshunova and Arkhina, 1948: 291 - 298), dog (Pomerantzev, 1950: 144 - 149), domestic animals (Pomerantzev, 1946: 17, 18).

Larva and nymph - Microtus species (Petriayev, 1946: 84 - 85; Petrova-Piontkovskaya, 1941: 122 - 134), small wild animals and birds (Dubinin, 1948: 275 - 286), Citellus eversmanni (Petrova-Piontkovskaya, 1941: 122 - 134), marmots and field mice (Korshunova and Petrova-Piontkovskaya, 1948: 243 - 250).

Larva - Citellus eversmanni and Stenocranius (Microtus) gregalis (Krontovskaya and Shmatikov, 1943: 65 - 68), field mice, rats, marmots, hamsters (Pomerantzev, 1950: 144 - 149).

Nymph - Citellus eversmanni (Korshunova and Arkhina, 1948: 291 - 298), field mice, rats, marmots, hamster, hares, cats, dogs (Pomerantzev, 1950: 144 - 149).

Seasonal activity: The adults were active in April, May and June (Pomerantzev, 1950: 144 - 149; Dubinin, 1948: 275 - 286; Petrova-Piontkovskaya, 1941: 122 - 134) and after they reached their peak of abundance in the second half of May they declined in numbers toward the end of June (Dubinin, 1948: 275 - 286). The autumn infestation began at the end of August (Dubinin, 1948: 275 - 286) and continued into early September (Serdyukova and Khodahovsky, 1940: 17); however, the autumn infestation was lighter than the spring infestation (Dubinin, 1948: 275 - 286; Pomerantzev, 1950: 144 - 149). The larvae and nymphs occurred from the middle of June to the middle of August (Pomerantzev, 1950: 144 - 149; Krontovskaya and Shmatikov, 1943: 65 - 68), but some were found in November (Dubinin, 1948: 275 - 286). The larvae were present in maximum numbers at the end of June and the nymphs showed peak abundance in the second half of July (Pomerantzev, 1950: 144 - 149).

Habitats: All stages of D. nuttalli were common in areas overgrown with grasses (Krontovskaya and Shmatikov, 1943: 65 - 68) and in xerophilous steppe habitats (Dubinin, 1948: 275 - 286). However, they were absent from forest areas, river lowlands and hilly wooded country (Petrova-Piontkovskaya, 1941: 122 - 134).

Control Measures

The burning or the mowing of grass, the application of sprays, the dipping of cattle and the destruction of the rodent hosts were recommended (Krontovskaya and Shmatikov, 1943: 65 - 68).

Relation to Disease

Tick-borne Typhus: Dermacentor nuttalli was found to be a vector (Yatzimirskaya - Krontovskaya, 1939: 114 - 118; Aluimov, 1940: 338 - 339; Petrova-Piontkovskaya, 1941: 122 - 134; Korshunova, 1943: 59 - 64; Pletzity, 1947: 877 - 878; Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 144 - 149; Korshunova and Arkhina, 1948: 291 - 298; Korshunova and Petrova-Piontkovskaya, 1948: 243 - 250) and was also regarded as a persistent reservoir of the rickettsiae in nature (Korshunova and Petrova-Piontkovskaya, 1943: 87). The disease was prevalent in spring and early summer though isolated cases were observed in August-September (Yatzimirskaya-Krontovskaya, 1939: 114 - 118; Petrova-Piontkovskaya, 1941: 122 - 134; Korshunova, 1943: 59 - 64) and the peak of infection coincided with the maximum abundance of this species in nature (Yatzimirskaya-Krontovskaya, 1939: 114 - 118). The disease occurred among people who had inhabited the steppe regions and who had a history of tick bites (Petrova-Piontkovskaya, 1941: 122 - 134; Yatzimirskaya-Krontovskaya, 1939: 114 - 118). The causal agent persisted in ticks from stage to stage and from generation to generation (Yatzimirskaya-Krontovskaya, 1939: 114 - 118; Petrova-Piontkovskaya, 1941: 122 - 134; Korshunova and Petrova-Piontkovskaya, 1943: 87; Korshunova and Petrova-Piontkovskaya, 1948: 243 - 250). The rickettsiae were preserved in adults for 240 days at -2° C. and were later transmitted by all stages (Korshunova and Petrova-Piontkovskaya, 1948: 243 - 250). Marmots and field mice were found to be a reservoir of the infectious agent (Korshunova and Petrova-Piontkovskaya, 1948: 243 - 250). Different strains of rickettsiae were obtained from ticks taken in the field, on man, on Citellus and on rats; these strains were maintained by passage through

ticks for a period of over 7 months and evidence was obtained that the virus could be preserved in rats for over 60 days (Yatzimirskaya-Krontovskaya, 1939: 114 - 118). Strains of rickettsiae obtained from ticks were identical with strains obtained from humans (Korshunova and Petrova-Piontkovskaya, 1943: 87; Korshunova and Arkhina, 1948: 291 - 298). Ticks collected in nature yielded rickettsiae and this indicated a significant infection of ticks (Soliterman, 1944: 50; Petriayev, 1946: 84 - 85; Krontovskaya and Shmatikov, 1943: 65 - 68). Emulsions of washed salivary glands of engorged ticks taken off 2 patients suffering from tick-borne typhus caused an experimental infection in guinea pigs (Petriayev, 1946: 24 - 25).

Spring-Summer Encephalitis: In experimental studies the virus persisted for 10 1/2 months in D. nuttali and was later transferred through the eggs to the larvae of the second generation (Chumakov, et al., 1945: 18 - 24).

Piroplasmosis: D. nuttalli transmitted Babesia equi to horses (Pomerantzev, 1950: 144 - 149).

Miscellaneous: Heavy infestations of young sheep and cattle in the spring caused severe dermatitis or death (Dubinin, 1948: 275 - 286).

Dermacentor pavlovskyi Olenev

Dermacentor pavlovskyi Olenev, 1927: 84 - 85; Olenev, 1927: 222; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1930: 604 - 610; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pomerantzev, 1946: 15, 17; Afanaseva, 1946: 38 - 42; Pomerantzev, 1950: 141 - 143.

Localities and Hosts

Turkestan - Syr Darya region (Olenev, 1929: 305 - 314), on Ovis nigrimontana (Olenev, 1927: 84 - 85; Olenev, 1928: 84 - 96). Central Asia - (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125). Kazakh S. S. R. - southern Kara Tau mountains (Olenev, 1931: 3 - 125; Pomerantzev, 1946: 15, 17; Pomerantzev, 1950: 141 - 143), on Ovis nigrimontana (Olenev, 1930: 604 - 610). Uzbek S. S. R. - Fergana, on goat (Olenev, 1930: 604 - 610; Pomerantzev, 1946: 15, 17); Tashkent (Olenev, 1931: 3 - 125; Pomerantzev, 1946: 15, 17; Pomerantzev, 1950: 141 - 143). Kirghiz S. S. R. - Frunze, western part of Transilii

Ala-tau (Pomerantzev, 1950: 141 - 143). On following hosts without definite indication of locality - Ovis nigrimontana, cattle, sheep, goat (Olenev, 1931: 3 - 125; Pomerantzev, 1946: 15, 17; Pomerantzev, 1950: 141 - 143).

Biology

Hosts of stages: Only the adults are known and they occurred on the hosts mentioned above.

Seasonal activity: The adults were active from March to the beginning of April (Pomerantzev, 1950: 141 - 143).

Habitats: The males and females were found near mountainous semi-deserts (Olenev, 1931: 3 - 125) and occurred exclusively in the mountains of Central Asia (Pomerantzev, 1950: 141 - 143).

Dermacentor pictus Herm.

Cynorhaestes pictus Hermann, 1804: 64.

Dermacentor pictus, Schulze, 1933: 427, 429; Olenev, 1934: 672 - 674; Schulze, 1935: 178 - 186; Alfeev, 1940: 23 - 25; Olsufiev, 1940: 26 - 28; Pomerantzev and Matikashvili, 1940: 100 - 133; Olsufiev, 1941: 10 - 11; Naidenova, 1941: 20 - 21; Serdyukova, 1941: 135 - 144; Olsufiev, 1941: 436 - 439; Khatenever, 1942: 82 - 86; Karpov and Popov, 1944: 75 - 79; Chumakov, et al., 1945: 18 - 24; Pomerantzev, 1946: 16, 17; Kalabukhov and Shubladze, 1946: 68 - 75; Olsufiev, 1947: 255 - 262; Alfeev, 1947: 285 - 286; Olsufiev, 1947: 291 - 292; Pletzity, 1947: 46 - 51; Pletzity, 1947: 877 - 878; Alfeev, 1948: 50 - 60; Chumakov, 1948: 19 - 26; Pavlovsky, 1948: 587 - 590; Fedyushin, 1949: 485 - 494; Pomerantzev, 1950: 134 - 141; Olenev, 1950: 149 - 151; Bilibin, 1950: 200 - 207; Reznik, 1950: 327 - 328; Viskovsky, 1951: 386 - 388; Shatas, 1952: 802 - 818; Melnikova, 1953: 422 - 434; Gajdusek, 1953: 1 - 140; Kratokhvil, 1954: 61 - 63.

Ixodes marmoratus Risso, 1826: 183; Pomerantzev, 1950: 134 - 141.

Dermacentor pardalinus Koch, 1844: 235 - 236; Pomerantzev, 1950: 134 - 141.

Dermacentor ferrugineus Koch, 1844: 235 - 236; Pomerantzev, 1950: 134 - 141.

Dermacentor reticulatus, Neumann, 1897: 363; Neumann, 1911: 99 - 100; in part; Belitzer, 1914: 73 - 78; Marzinovsky, 1914: 714 - 735;

Markov, 1916: 313 - 335; Yakimov, 1917: 298 - 301; Knuth, et al., 1918: 241 - 264; Kotlán, 1919: 34 - 35; Watanabe, et al., 1921: 149 - 174; Kotlán, 1921: 43 - 50; Yakimov, 1922: 41 - 46; Vinogradov and Yakimov, 1924: 1 - 2; Yakimov and Vasilevskaya, 1924: 52 - 64; Belitzer, 1925: 51 - 56; Zakharov, 1926: 53 - 59; Belitzer, 1927: 50 - 55; Olenev, 1927: 451 - 454; Olenev, 1927: 219 - 224; Yakimov, et al., 1928: 644 - 646; Martini, 1928: 134 pp.; Olenev, 1928: 35 - 39; Olenev, 1928: 84 - 96; Belitzer, 1929: 258 - 262; Belitzer, 1929: 439 - 440; Olenev, 1929: 305 - 314; Belitzer and Markov, 1930: 598 - 601; Olenev, 1930: 604 - 610; Olenev, 1931: 126 - 139; Zasukhin, 1935: 1 - 159; Schulze, 1935: 178 - 186; Zasukhin, 1936: 219 - 226; Mlinac and Oswald, 1936: 415 - 421; Zasukhin, 1936: 457 - 460; Yamashita, 1939: 602 - 609; Karpov and Popov, 1944: 75 - 79; Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141.

Dermacentor marginatus, Olenev, 1931: 3 - 125; Alfeev, 1939: 66 - 80; Alfeev, 1939: 99 - 109.

Dermacentorites marginatus, Olenev, 1931: 88 - 90.

Localities and Hosts

Europe

Germany - (Pomerantzev, 1950: 134 - 141). Hungary - (Kotlán, 1919: 34 - 35), on dogs, pigs, sheep, cattle (Kotlán, 1921: 43 - 50). Jugoslavia - (Mlinac and Oswald, 1936: 415 - 421). Macedonia - on horses (Knuth, et al., 1918: 241 - 264). Poland - (Pomerantzev, 1950: 134 - 141); Rumania - (Knuth, et al., 1918: 241 - 264).

Asia

Manchuria - on cattle (Yamashita, 1939: 602 - 609).

U. S. S. R.

Byelorussian S. S. R. - on cattle (Naidenova, 1941: 20 - 21). Kazakh S. S. R. - eastern part (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141); northeastern part (Olenev, 1930: 604 - 610); Uralsk Province (Belitzer, 1941: 73 - 78). Kirghiz S. S. R. - (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141).

R. S. F. S. R. - (Yakimov, 1917: 298 - 301; Olenev, 1927: 451 - 454), on horses (Marzinovsky, 1914: 714 - 735); European part (Ole-

nev, 1928: 35 - 39; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125); northern parts, on horse, man, small mammals (Belitzer, 1914: 73 - 78); central provinces (Yakimov, 1922: 41 - 46), on horses, small rodents (Belitzer, 1925: 51 - 56; Olsufiev, 1947: 255 - 262), cattle, sheep, hares, foxes, wolf, man, field mice, Microtus arvalis, insectivores, water rats (Olsufiev, 1947: 255 - 262); Amur Province - on horses (Watanabe, et al., 1921: 149 - 174). Gorkiy Province (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141; Ivanovo Province (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141); Kemerovo Province (Pletzity, 1947: 46 - 51; Pletzity, 1947: 877 - 878); Kursk Province (Belitzer, 1914: 73 - 78; Leningrad Province (Alfeev, 1940: 23 - 25); Moscow Province: (Olsufiev, 1947: 255 - 262; Pomerantzev, 1950: 134 - 141; Pomerantzev, 1946: 16, 17); southern part, on Microtus arvalis (Olsufiev, 1941: 10 - 11; Olsufiev, 1940: 26 - 28), sheep, cattle, dogs, horses, Arvicola amphibius, Sorex araneus (Olsufiev, 1940: 26 - 28); Mikhnevo District (Kalabukhov and Shubladze, 1946: 68 - 75); Novosibirsk Province: (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141); Tschanov District, on cattle, horses, sheep, dogs, hares, field mice, Putorius eversmanni (Olsufiev, 1947: 291 - 292); Omsk Province (Bilibin, 1950: 200 - 207; Viskovsky, 1951: 386 - 388; Gajdusek, 1953: 1 - 140), on Microtus (Stenocranius) gregalis, man (Chumakov, 1948: 19 - 26), cattle, rodents (Fedyushin, 1949: 485 - 494), dogs, small mammals (Belitzer and Markov, 1930: 598 - 601); Orel Province (Olsufiev, 1947: 255 - 262), on cattle (Alfeev, 1947: 285 - 286; Alfeev, 1939: 99 - 109), large domestic animals, dogs, wolf, Insectivora and rodents (Alfeev, 1939: 99 - 109); Ryazan Province (Pomerantzev, 1946: 16, 17; Olsufiev, 1947: 255 - 262; Pomerantzev, 1950: 134 - 141), on horses (Belitzer, 1927: 50 - 55; Belitzer, 1929: 258 - 262), small rodents (Belitzer, 1929: 258 - 262); Saratov Province (Belitzer, 1914: 73 - 78; Yakimov, 1922: 41 - 46; Martini, 1928: 1 - 134), on hedgehogs (Vinogradov and Yakimov, 1924: 1 - 2); Smolensk Province: (Pomerantzev, 1950: 134 - 141), Velezh (Olenev, 1934: 672 - 674); Stalingrad Province: Kikvidze, Kamyschinsky, Olkkovska, Verkhne-Kurmoyarskaya, on cattle (Shatas, 1952: 802 - 818); Sverdlovsk Province: Kamyshlov (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141); Tula Province (Olsufiev, 1947: 255 - 262); Tyumen Province: (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141), Tobolsk (Belitzer, 1914: 73 - 78); Velikiye-Luki Province: Sebezh, Loknya, Velikiye-Luki (Olenev, 1934: 672 - 674); Voronezh Province (Belitzer, 1941: 73 - 78).

Crimean A. S. S. R. - (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141), on domestic animals (Melnikova, 1953: 422 - 434). Altai Territory - western part (Pomerantzev, 1946: 16, 17; Pomerant-

zev, 1950: 134 - 141). Stavropol Territory - (Reznik, 1950: 327 - 328). Krasnoyarsk Territory - Kansk (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141). Western Territory - (Olenev, 1934: 672 - 674; Pomerantzev, 1946: 16, 17). Primor Territory (Belitzer, 1914: 73 - 78). Caucasia - northern part (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141), on cattle (Yakimov, et al., 1928: 644 - 646; Zakharov, 1926: 53 - 59), horses, sheep (Zakharov, 1926: 53 - 59). Siberia - central part (Karpov and Popov, 1944: 75 - 79); western part (Karpov and Popov, 1944: 75 - 79; Olenev, 1928: 35 - 39); up to Tomsk Province (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125). Transcaucasia - (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141); central and eastern part, on cattle, horse, sheep, buffalo, dog, swine, goat, donkey (Pomerantzev and Matikashvili, 1940: 100 - 133). Turkestan - on cattle (Yakimov, 1917: 298 - 301).

On following hosts without definite indication of locality: domestic animals, large wild mammals (Pomerantzev, 1946: 16, 17), hares (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141), hedgehog (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141), insectivores (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141), rodents (Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141; Olenev, 1928: 84 - 96; horse (Pomerantzev, 1950: 134 - 141; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), donkey (Pomerantzev, 1950: 134 - 141; Olenev, 1931: 3 - 125), cattle (Pomerantzev, 1950: 134 - 141; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), buffalo (Pomerantzev, 1950: 134 - 141; Olenev, 1931: 3 - 125), sheep (Pomerantzev, 1950: 134 - 141; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), goat (Pomerantzev, 1950: 134 - 141; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), deer (Pomerantzev, 1950: 134 - 141; Olenev, 1928: 84 - 96), swine (Pomerantzev, 1950: 134 - 141; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), dog (Pomerantzev, 1950: 134 - 141; Olenev, 1931: 3 - 125), small carnivores (Pomerantzev, 1950: 134 - 141), man (Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), Lepus species (Olenev, 1931: 3 - 125).

Biology

Life history: D. pictus was found to be a three host tick (Pomerantzev, 1950: 141) and most of the adults hibernated twice before feeding so that the life cycle lasted two years. Some individuals fed earlier, which explained the occurrence of ticks, chiefly males, on cattle in September (Olsufiev, 1940: 26 - 28).

In the early spring the adults were very active but in the summer they reversed their behavior and exhibited prolonged geotropism. Females which fed in the spring oviposited (Alfeev, 1947: 285 - 286). Oviposition took place in the second half of May and in June. Hot and dry weather favored development of the immature stages but they were killed by prolonged cooling, being unable to overwinter. The young adults which appeared in August and September were inactive and hibernated in the upper layers of the soil (Olsufiev, 1940: 26 - 28). Adults were kept unfed in the laboratory for up to two years at 4° C. (Olsufiev, 1941: 436 - 439).

Host of stages: Adult - dogs (Kotlán, 1921: 43 - 50; Olsufiev, 1940: 26 - 28; Olsufiev, 1947: 291 - 292; Belitzer and Markov, 1930: 598 - 601; Alfeev, 1939: 99 - 109; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 134 - 141; Olenev, 1931: 3 - 125), swine (Kotlán, 1921: 43 - 50; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 134 - 141; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), sheep (Kotlán, 1921: 43 - 50; Olsufiev, 1947: 255 - 262; Olsufiev, 1940: 26 - 28; Olsufiev, 1947: 291 - 292; Zakharov, 1926: 53 - 59; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 134 - 141; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), cattle (Kotlán, 1921: 43 - 50; Yamashita, 1939; 602 - 609; Naidenova, 1941: 20 - 21; Olsufiev, 1947: 255 - 262; Olsufiev, 1940: 26 - 28; Olsufiev, 1947: 291 - 292; Fedyushin, 1949: 485 - 494; Alfeev, 1947: 285 - 286; Alfeev, 1939: 99 - 109; Shatas, 1952: 802 - 818; Zakharov, 1926: 53 - 59; Yakimov, et al., 1928: 644 - 646; Pomerantzev and Matikashvili, 1940: 100 - 133; Yakimov, 1917: 298 - 301; Pomerantzev, 1950: 134 - 141; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), horses (Knuth, et al., 1918: 241 - 264; Olsufiev, 1947: 255 - 262; Belitzer, 1914: 73 - 78; Marzinovsky, 1914: 714 - 735; Belitzer, 1925: 51 - 56; Watanabe, et al., 1921: 149 - 174; Olsufiev, 1940: 26 - 28; Olsufiev, 1947: 291 - 292; Belitzer, 1927: 50 - 55; Belitzer, 1929: 258 - 262; Zakharov, 1926: 53 - 59; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 134 - 141; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), hares (Olsufiev, 1947: 255 - 262; Olsufiev, 1947: 291 - 292; Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141), foxes (Olsufiev, 1947: 255 - 262), wolf (Olsufiev, 1947: 255 - 262; Alfeev, 1939: 99 - 109), man (Olsufiev, 1947: 255 - 262; Belitzer, 1914: 73 - 78); Chumakov, 1948: 19 - 26; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), large domestic animals (Alfeev, 1939: 99 - 109; Melnikova, 1953: 422 - 434; Pomerantzev, 1946: 16, 17), hedgehog (Vinogradov and Yakimov, 1924: 1 - 2; Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141), buffalo (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev,

1950: 134 - 141; Olenev, 1931: 3 - 125), goat (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 134 - 141, Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), donkey (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 134 - 141; Olenev, 1931: 3 - 125), large wild mammals (Pomerantzev, 1946: 16, 17), deer (Pomerantzev, 1950: 134 - 141; Olenev, 1928: 84 - 96), Lepus species (Olenev, 1931: 3 - 125).

Nymph - horses (Knuth, et al., 1918: 241 - 264), Microtus arvalis (Olsufiev, 1947: 255 - 262), small rodents (Belitzer, 1929: 258 - 262).

Nymph and larva - field mice (Olsufiev, 1947: 255 - 262; Olsufiev, 1947: 291 - 292), insectivores (Olsufiev, 1947: 255 - 262; Alfeev, 1939: 99 - 109; Pomerantzev, 1946: 16, 17; Pomerantzev, 1950: 134 - 141), small rodents (Belitzer, 1914: 73 - 78; Belitzer, 1925: 51 - 56; Fedyushin, 1949: 485 - 494; Alfeev, 1939: 99 - 109; Pomerantzev, 1946: 16, 17), Microtus arvalis (Olsufiev, 1940: 26 - 28; Olsufiev, 1941: 10 - 11), Arvicola amphibius, Sorex araneus (Olsufiev, 1940: 26 - 28), hares (Olsufiev, 1947: 291 - 292; Pomerantzev, 1950: 134 - 141), Putorius eversmanni (Olsufiev, 1947: 291 - 292), Microtus (Stenocranius) gregalis (Chumakov, 1948: 19 - 26), small mammals (Belitzer and Markov, 1930: 598 - 601), hedgehogs, small carnivores (Pomerantzev, 1950: 134 - 141).

Seasonal activity: In areas of mild climate in the U. S. S. R. the adults were active from the end of March to the beginning of June and in the autumn from the end of August on. None were found in mid-summer or in winter. The larvae and nymphs were active from June to August. In the south where the climate was milder the activity of all stages extended through the winter (Pomerantzev, 1950: 134 - 141; Olsufiev, 1947: 255 - 262; Belitzer, 1914: 73 - 78; Belitzer, 1925: 51 - 56).

In Moscow Province the adults were active from April, when the snow melted, until the beginning of June when the hot weather began, but some adults, chiefly males, were found on cattle in September. The larvae occurred from the end of June to the beginning of August and the nymphs were abundant in the second half of July (Olsufiev, 1940: 26 - 28).

In Transcaucasia the adults were active from August to April, covering the autumn, winter and spring seasons but none were found in May, June and July, They showed two small peaks of abundance, one in the autumn (September-October) and one in the spring (March) but they were also found during the winter months (November, December, January and February) (Pomerantzev and Matikashvili, 1940: 100 - 133).

In Byelorussian S. S. R. adults were collected from May 20 to June 1 but none were found after this period (Naidenova, 1941: 20 -

21). In Stalingrad Province single specimens were collected free in nature from April to June and were taken on cattle from December to April (Shatas, 1952: 802 - 818).

In Novosibirsk Province the adults were found in the spring in great numbers on domestic animals. At the end of July almost all field mice were infested with immature ticks. The larvae were found in significant numbers on animals throughout July but occurred only singly in August. The first nymphs were found July 13 reaching their maximum abundance between July 15 and 30 but after this period they decreased in numbers. On August 13 larvae and nymphs were still found but only as single specimens. Adults, almost exclusively males, were also found in July but in very small numbers, but in August the findings were more frequent (Olsufiev, 1947: 291 - 292).

Habitats: The preferred habitats of all stages were moderately damp meadows but they also occurred in small deciduous woods, mixed forests, forest clearings, shrub vegetation and steppe regions (Olsufiev, 1940: 26 - 28; Pomerantzev and Matikashvili, 1940: 100 - 133; Olsufiev, 1941: 10 - 11; Khatenever, 1942: 82 - 86; Karpov and Popov, 1944: 75 - 79; Olsufiev, 1947: 255 - 262; Olsufiev, 1947: 291 - 292; Pletzity, 1947: 46 - 51; Pletzity, 1947: 877 - 878; Melnikova, 1953: 422 - 434). They were scarce in coniferous forests and in cultivated land far from meadows and woods (Olsufiev, 1940: 26 - 28; Karpov and Popov, 1944: 75 - 79; Melnikova, 1953: 422 - 434).

Tick parasites: Hunterellus hookeri which had been received from Montana developed in nymphs of D. pictus and they were larger and more active than those which developed in I. ricinus (Alfeev, 1940: 23 - 25).

Control Measures

In Omsk investigations were carried out in the forest steppe zone to ascertain the effects of pasture improvement on D. pictus. These improved pastures were maintained for about five years in a program of crop rotation by sowing grass on plowed land and by harrowing them periodically. Though the ticks still occurred in the improved pasture they were less numerous than in natural pastures. The number of rodents present and the percentage of them infested by larvae and nymphs were also smaller in the improved pastures and hardly any ticks were collected by drags in them. When ticks were exposed on a plot that had been plowed and was devoid of vegetation the winter mortality was complete. The dead ticks were found in the upper two inches of the soil. The survi-

val of the unfed ticks after plowing was found to be in inverse proportion to the plowing depth and to the humidity of the soil (Fedyushin, 1949: 485 - 494).

Tests conducted on the toxicity of ticks to the volatile fractions of various plants showed that winter buds of Prudus padus killed the larvae in 10 - 12 minutes while the bark killed them in 3 - 5 minutes (Olenev, 1950: 149 - 151).

Relation to Disease

Tularemia: D. pictus transmitted Bacterium tularense (Olsufiev, 1940: 26 - 28; Olsufiev, 1941: 10 - 11; Khatenever, 1942: 82 - 86; Karpov and Popov, 1944: 75 - 79; Olsufiev, 1947: 255 - 262; Pomerantzev, 1950: 134 - 141) and also served as a long term reservoir (Olsufiev, 1947: 255 - 262; Olsufiev, 1941: 10 - 11; Karpov and Popov, 1944: 75 - 79; Pomerantzev, 1950: 134 - 141). Adults were found spontaneously infected with B. tularense (Khatenever, 1942: 82 - 86; Karpov and Popov, 1944: 75 - 79; Olsufiev, 1947: 255 - 262) and were capable of passing the infection on to their progeny (Pomerantzev, 1950: 134 - 141; Olsufiev, 1941: 10 - 11; Khatenever, 1942: 82 - 86; Karpov and Popov, 1944: 75 - 79). Larvae and nymphs of D. pictus transmitted the infection to field mice during the summer months (Olsufiev, 1947: 255 - 262; Khatenever, 1942: 82 - 86; Olsufiev, 1941: 10 - 11). In laboratory experiments B. tularense was transmitted by nymphs to guinea pigs and to Microtus and by adults to guinea pigs and rabbits. Microtus and white mice also acquired the infection by eating infected ticks (Olsufiev, 1941: 10 - 11).

Omsk Haemorrhagic Fever: The causative agent of this disease was isolated 3 times from emulsions of ground up D. pictus (Chumakov, 1948: 19 - 26) and this species was thought to be a vector as well as a long term reservoir of the virus (Bilibin, 1950: 200 - 207; Viskovsky, 1951: 386 - 388; Gajdusek, 1953: 1 - 140).

Erysipeloid: The causative agent was isolated from larvae and nymphs but was not retained in the ticks during metamorphosis from larvae to nymphs (Kratokhvil, 1954: 61 - 63).

Piroplasmosis: The adults transmitted B. caballi to horses in various parts of the Soviet Union (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 134 - 141; Belitzer, 1914: 73 - 78; Marzinovsky, 1914: 714 - 715; Markov, 1916: 313 - 335; Watanabe, et al., 1921: 149 - 174; Yakimov, 1922: 41 - 46; Belitzer, 1925: 51 - 56; Zakharov, 1926: 53 - 59; Olenev, 1931: 3 - 125).

Infected nymphs did not transmit the infection (Vinogradov and Yakimov, 1924: 1 - 2; Belitzer, 1929: 258 - 262) but when these nymphs molted to adults they infected the same animal with piroplasmosis (Belitzer, 1929: 258 - 262). D. pictus also transmitted Babesia equi to horses (Pomerantzev, 1950: 134 - 141). Larvae and nymphs did not transmit Babesia canis to dogs but adults that had been fed as larvae and nymphs on infected mice did (Belitzer and Markov, 1930: 598 - 601) and it was regarded as a vector of canine piroplasmosis (Olenev, 1931: 3 - 125; Pomerantzev, 1950: 134 - 141).

Encephalitis: In experiments the virus of Japanese-B encephalitis persisted for 13 months in D. pictus and the virus was passed on to the progeny (Chumakov, et al., 1945: 18 - 24).

Equine Encephalo-myelitis: D. pictus transmitted the virus to horses (Pomerantzev, 1950: 134 - 141).

Miscellaneous: The feeding of 31 females was fatal to a guinea pig and the feeding of 40 - 50 or more nymphs proved fatal to small rodents, including Microtus arvalis (Olsufiev, 1941: 10 - 11).

Dermacentor pomerantzevi Serdyukova

Dermacentor pomerantzevi Serdyukova, 1951: 909 - 912; Shatas, 1952: 802 - 818.

This species was described only from the female taken on a hedgehog in Dubovsky district of Stalingrad Province on July 14, 1949 (Serdyukova, 1951: 902 - 919; Shatas, 1952: 802 - 818). The type was deposited in the Zoological Institute, Academy of Science, U. S. S. R. (Serdyukova, 1951: 909 - 912).

Dermacentor raskemensis Pomerantzev

Dermacentor raskemensis Pomerantzev, 1948: 20 - 24; Pomerantzev, 1946: 16; Pomerantzev, 1950: 164 - 165).

This species was described from a male found in the Raskem region of southeastern Turkestan in November (Pomerantzev, 1948: 20 - 24; Pomerantzev, 1946: 16; Pomerantzev, 1950: 164 - 165). The type was deposited in the Zoological Institute, Academy of Science, U. S. S. R. (Pomerantzev, 1950: 164 - 165).

Dermacentor silvarum Olenev

Dermacentor silvarum Olenev, 1931: 126 - 139, in part; Olenev, 1931: 3 - 125, in part; Olenev and Kastrov, 1932: 28 - 30; Zasukhin, 1932: 181 - 185; Olenev, 1931: 126 - 219, in part; Golov, 1933: 32 - 38; Zasukhin, 1933: 31 - 46; Zasukhin, 1933: 277 - 282; Olenev, 1934: 367 - 388; Olenev, 1934: 672 - 674; Pavlovsky and Pomerantzev, 1934: 49 - 62; Zolotarev, 1934: 217 - 227; Yakimov, et al., 1934: 235 - 254; Kurchatov and Kalmikov, 1934: 80 pp.; Markov, et al., 1935: 106 - 109; Kochetkov, 1935: 124 - 127; Shpringgoltz-Shmidt, 1935: 137 - 186; Zasukhin, 1935: 1 - 159; Pospelova-Shtrom, 1935: 135 - 148; Zasukhin, 1935: 261 - 264; Schulze, 1935: 178 - 186; Galuzo and Bespalov, 1935: 199 - 204; Shpringgoltz-Shmidt, 1936: 123 - 147; Pogorely, 1936: 533 - 537; Olsufiev and Golov, 1936: 187 - 226; Zasukhin, 1936: 219 - 226; Zasukhin, 1936: 155 - 164; Zasukhin, 1936: 461 - 470; Zasukhin, 1936: 457 - 460; Potschetschuev, 1937: 298 - 301; Rastegaeva, 1937: 479 - 480; Zasukhin and Tikhomirova, 1937: 357 - 362; Antonov and Naishtat, 1937: 73 - 81; Orlov and Lonziger, 1938: 287 - 302; Mironov, 1938: 415 - 434; Pavlovsky, 1939: 94 - 95; Ryzhov and Skrynnik, 1939: 109 - 110; Pomerantzev and Serdyukova, 1940: 336 - 337; Pavlovsky, 1940: 58 - 71; Smorodintsev, 1940: 468 - 480; Mironov, 1940: 93 - 105; Levkovich and Skrynnik, 1940: 118 - 121; Kurchatov, 1940: 26 - 29; Kurchatov and Sokolov, 1940: 35; Kurchatov, 1940: 32; Blagoveshchensky, 1940: 15 - 17; Pisyaukova, 1941: 65 - 80; Ryzhov and Kozlova, 1941: 34 - 40; Pervomaisky, 1941: 81 - 94; Levkovich and Skrynnik, 1941: 19 - 22; Zhmaeva, 1941: 14; Skrynnik and Ryzhov, 1941: 41 - 49; Ryzhov and Skrynnik, 1941: 27 - 33; Markov, 1941: 22 - 23; Kozlova and Grachev, 1941: 17 - 19; Galuzo, 1941: 51 - 55; Orlov, 1941: 45 - 47; Khatenever, 1942: 82 - 86; Gruzdeva, 1943: 102 - 104; Savitskaya, 1943: 87; Levkovich, 1943: 49 - 53; Krontovskaya and Shmatikov, 1943: 65 - 68; Bocharova, 1943: 68 - 72; Demidov, et al., 1944: 22; Shkorbatov, 1944: 43 - 46; Karpov and Popov, 1944: 75 - 79; Marikovsky, 1945: 60 - 66; Nelzina, 1945: 55 - 60; Pavlovsky, 1945: 65 - 92; Chumakov, et al., 1945: 18 - 24; Pomerantzev, 1946: 17, 18; Kasyanov, 1947: 14 - 15; Pletzity, 1947: 46 - 51; Pomerantzev and Serdyukova, 1947: 47 - 67; Pavlovsky, 1947: 160 - 201; Pavlovsky, 1947: 265 - 285; Pletzity, 1947: 877 - 878; Egorov and Leontev, 1948: 35 - 37; Pavlovsky, 1948: 590; Blagoveshchensky, 1948: 83 - 113; Pomerantzev and Serdyukova, 1948: 47 - 67; Dubinin, 1948: 275 - 286;

Pomerantzev, 1950: 159 - 163.

Localities and Hosts

Asia

Mongolia - northern part (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 159 - 163).

U. S. S. R.

U. S. S. R. - (Olenev, 1931: 126 - 139; Kurchatov and Kalmykov, 1934: 80 pp.). Armenian S. S. R. - (Pavlovsky and Pomerantzev, 1934: 49 - 62). Azerbaijan S. S. R. - on zebu (Yakimov, et al., 1934: 235 - 254). Byelorussian S. S. R. - Polesska Province: Khoiniksky District (Olenev, 1934: 672 - 674). Kazakh S. S. R. - on domestic animals (Galuzo, 1941: 51 - 55); western part (Markov, et al., 1935: 105 - 109); Slomikhina (Zasukhin, 1935: 1 - 159), on calf (Zasukhin, 1933: 31 - 46), Hemiechinus auritus (Zasukhin, 1936: 219 - 226); Talovka; Urda; Lbischensk; Uschtagon (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159); southeastern part, on hares, Arvicola terrestris (Olsufiev and Golov, 1936: 187 - 226); Alma Ata Province: vicinity of Alma Ata, on Arvicola terrestris, Microtus arvalis, cattle man (Golov, 1933: 32 - 38); Zapadno-Kazakh Province: Uralsk; Dzhambeyty (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Kalmykovo (Zasukhin, 1933: 31 - 46), Novaya Kazanka (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), on Hemiechinus auritus (Zasukhin, 1936: 219 - 226); Aktyubinsk Province: Irgiz (Zasukhin, 1935: 1 - 159). Tadzhik S. S. R. - western part (Galuzo and Bespalov, 1935: 199 - 204); Gissar Valley, on cattle, goats (Pospelova-Shtrom, 1935: 135 - 148). Ukrainian S. S. R. - on sheep (Rastegaeva, 1937: 479 - 480); Voroshilovgrad Province: Belovodsk, on horses, cattle, sheep, pigs, dogs, man, wolf, fox, hedgehog (Pogorely, 1936: 533 - 537).

Bashkirskaya A. S. S. R. - Ufa; Sterlitamak (Olenev, 1934: 367 - 388). Crimean A. S. S. R - on horses (Kurchatov and Sokolov, 1940: 35), cattle (Kurchatov, 1940: 32). Daghestan A. S. S R. - on cattle, horse, sheep (Zolotarev, 1934: 217 - 227); Baba-iurt, on cattle, horse; DNKZ veterinary district on sheep; Buynaksk, on cattle (Olenev and Kastrov, 1932: 28 - 30). Tatarskaya, A. S. S. R. - Bugulina (Olenev, 1934: 367 - 388). Yakutskaya A. S. S. R. - (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 159 - 163). Birobidzhan Autonomous Region - (Pavlovsky, 1947: 160 - 201), Altai Territory -

eastern part (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 159 - 163). Khabarovsk Territory - (Levkovich and Skrynnik, 1940: 118 - 121; Pisyaukova, 1941: 65 - 80; Ryzhov and Skrynnik, 1941: 27 - 33; Savitskaya, 1945: 87; Pletzity, 1947: 877 - 878), on cattle, horses (Skrynnik and Ryzhov, 1941: 41 - 49; Kasyanov, 1947: 14 - 15), dogs (Skrynnik and Ryzhov, 1941: 41 - 49), sheep, reindeer (Kasyanov, 1947: 14 - 15), man (Shkorbatov, 1944: 43 - 46); Ussuri River Districts and Middle Amur River Districts, on man (Antonov and Naishtat, 1937: 73 - 81); Komsomolsk District and Khabarovsk District, on cattle, horses, swine, dogs, cats, sheep, goats, man, cattle, Sciuris vulgaris, Eutamias asiaticus orientalis, Rattus norvegicus caraco, Apodemus speciosus praetor, Evotomys rufocanus, Sorex species, Emberiza aureola ornata, Emberiza spodocephala extremi-orientis, Anthus hodgsoni, Phylloscopus fuscatus, Phragmaticola aëdon, Leuconotopicus minor amurensis, Capella megala, field mouse, Lepus mantschuricus, eastern field mouse, Kolonocus species (Blagoveshchensky, 1948: 83 - 113). Primor Territory - (Mironov, 1940: 93 - 105; Ryzhov and Kozlova, 1941: 34 - 40; Zhmaeva, 1941: 14; Gruzdeva, 1943: 102 - 104; Marikovsky, 1945: 60 - 66; Pomerantzev, 1946: 17, 18; Pavlovsky, 1947: 160 - 201; Pomerantzev, 1950: 159 - 163), domestic animals (Nelzina, 1945: 55 - 60), man (Pervomaisky, 1941: 81 - 94; Nelzina, 1945: 55 - 60); Suputin National Forest (Kozlova and Grachev, 1941: 17 - 19), cattle (Pomerantzev and Serdyukova, 1940: 336 - 337); Vladivostok and Ussuri River Districts, on man (Antonov and Naishtat, 1937: 73 - 81); vicinity of Khanka Lake (Mironov, 1938: 415 - 434); Voroshilov (Pavlovsky, 1947: 265 - 285); Barabash Region (Pavlovsky, 1947: 265 - 285). Stavropol Territory - on cattle (Kurchatov, 1940: 26 - 29); Mineralnyye Vody, on cattle; Zhileznovodsk, on cattle; Georgiyevsk, on cattle (Olenev and Kastrov, 1932: 28 - 30).

Caucasia - northern part (Demidov, et al., 1944: 22); Divinsky District, on cattle; Prikumsky District, on cattle; Aksai, on cattle (Olenev and Kastrov, 1932: 28 - 30). Russian Far East - (Pomerantzev and Serdyukova, 1940: 336 - 337; Pavlovsky, 1945: 65 - 92; Pletzity, 1947: 877 - 878; Pomerantzev and Serdyukova, 1948: 47 - 67); southeastern part of coastal zone, on cattle, deer, wolves, horses (Shpringgoltz-Shmidt, 1935: 137 - 186). Siberia - central part (Krontovskaya and Shmaitkov, 1943: 65 - 68); western part, on cattle (Karpov and Popov, 1944: 75 - 79). Trans-Baikal Region - (Pomerantzev, 1946: 17, 18; Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 159 - 163). Trans-Ural Region - on domestic animals (Kochetkov, 1935: 124 - 127). Volga Region - middle and lower Volga (Markov, et al., 1935: 106 - 109), on Cricetus cricetus,

small mammals (Orlov, 1941: 45 - 47); Berezov; Ahtubinsk (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Ivantelvsk; Illieshleish; Tomalinsk; Bekorsk; Serdobsk; Khavalinsk; Turkovsk; Baladinsk; Kaminshensk; Korobalansk; Voskresensk; Tlovlinsk; Lisogorsk; Urazovsk; Tatischevsk; Krasnoyarsk (Zasukhin, 1935: 1 - 159).

R. S. F. S. R. - southern and northern districts, on horses (Zasukhin, 1932: 181 - 185); southeastern part, on horses, dogs, Microtus arvalis, Lagurus lagurus, Alactaga jaculus, Cricetus cricetus, Citellus pygmaeus, Apodemus agrarius, Apodemus sylvaticus, Arvicola amphibius, Mustela nivalis, Putorius eversmanni, Erinaceus rumanicus, Hemiechinus auritus (Zasukhin, 1935: 261 - 264); Amur Province: Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 159 - 163); Dep River Area (Olenev, 1934: 367 - 388); Lower Amur River Area (Blagoveshchensky, 1940: 15 - 17); Astrakhan Province: Kharabali (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159); Chelyabinsk Province: Chelyabinsk District, on horse (Olenev, 1934: 367 - 388); Chita Province: on domestic animals (Dubinin, 1948: 275 - 286); Grozny Province: Chernyy Rynok, on cattle (Olenev and Kastrov, 1932: 28 - 30); Irkutsk Province: Irkutsk (Olenev, 1934: 367 - 388); western shore of Lake Baikal in vicinity of Irkutsk (Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 159 - 163); Kemerovo Province (Pletzity, 1947: 46 - 51; Pomerantzev, 1950: 159 - 163), on cattle and rodents (Pletzity, 1947: 877 - 878); Saratov Province: on cattle, pigs, rodents (Orlov and Lonziger, 1938: 287 - 302); Saratov district, on Erinaceus rumanicus (Zasukhin, 1936: 219 - 226); vicinity of Saratov (Zasukhin, 1935: 1 - 159), on horse (Zasukhin, 1933: 31 - 46), Erinaceus rumanicus (Zasukhin, 1936: 155 - 164), Arvicola species, man (Zasukhin, 1937: 461 - 470), rodents, domestic animals, camels (Zasukhin, 1937: 461 - 470; Zasukhin and Tikhomirova, 1937: 357 - 362); Yekaterinova (Zasukhin, 1933: 31 - 46: Zasukhin, 1935: 1 - 159), on Erinaceus rumanicus (Zasukhin, 1936: 219 - 226); Dergachi (Zasukhin, 1935: 1 - 159), on horse, cattle, camel, Cricetus cricetus, Citellus rufescens, Citellus pygmaeus, Putorius eversmanni (Zasukhin, 1933: 31 - 46); Pugachev; Vol'sk; Ozink; Balashov; Novouzensk (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159); Romanovka; Atkarsk; Piterka; Samoylovka; Balakovo (Zasukhin, 1935: 1 - 159); Stalingrad Province: Leninsk (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159); Novo-Nikolayevskaya; Stalingrad, Kamyshin; Novo-Annenskiy (Zasukhin, 1933: 31 - 46); Ol'khovka; Kalach; Nekhavevskaya (Zasukhin, 1935: 1 - 159).

On following hosts without definite indication of locality: horse, cattle, sheep, dog (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 159 - 163), goat (Zasukhun, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), man (Zasukhin, 1933: 31 - 46; Zasukhin,

1933: 1 - 159; Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 159 - 163), camel, swine, cat (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Canis lupus, Vulpes vulpes (Zasukhin, 1935: 1 - 159; Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 159 - 163), Hemiechinus auritus, Cricetus cricetus, Alactaga jaculus, Alactagulus acontion, Citellus rufescens, Citellus pygmaeus, Putorius eversmanni (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Citellus suslica, Laguris laguris, Microtus arvalis, Mus musculus, Apodemus sylvaticus, Sorex species, Arvicola amphibius, Spalax microphthalamus, Mustela nivalis, Lepus europeus (Zasukhin, 1935: 1 - 159), Apodemus agrarius (Zasukhin, 1935: 1 - 159), domestic animals, Manchurian deer, spotted deer, rodents, small mammals, birds (Pomerantzev, 1946: 17, 18), Cervus canadensis xanthopygus, Capreolus pygargus bedfordi, Cervus nippon hortulorum, Nyctereutes procyonoides, Tigris tigris amurensis, Lepus mantschuricus, Apodemus agrarius mantschuricus, Evotomys rufocanus, Eutamias asiaticus orientalis, Lepus mantschuricus, Citellus eversmanni, Kolonocus sibericus coreanus, Rattus norvegicus caraco, Cricetulus nestor triton, Microtus michoi pellicus (Pomerantzev, 1950: 159 - 163).

Biology

Life history: Oviposition began 2 to 23 days after engorgement and lasted 15 to 36 days (Golov, 1933: 32 - 38). The eggs were deposited in crevices in soil under the roots of plants (Zasukhin, 1933: 31 - 46) or in marshy places under heavy shade (Galuzo, 1941: 51 - 55). The eggs were resistant to wide fluctuations in humidity (Shpringgoltz-Shmidt, 1935: 137 - 186). The egg stage lasted 11 to 60 days depending upon environmental factors (Golov, 1933: 32 - 38; Zasukhin, 1933: 31 - 46; Pogorely, 1936: 533 - 537; Shpringgoltz-Shmidt, 1935: 137 - 186).

The larvae engorged in 2 to 11 days and molted to the nymphal stage in 3 to 10 days. Unfed larvae survived up to 76 days (Golov, 1933: 32 - 38, Pogorely, 1936: 533 - 537) and became sluggish under conditions of insufficient moisture (Shpringgoltz-Shmidt, 1935: 137 - 186).

The nymphs engorged in 4 to 14 days and molted to adults in 12 to 29 days (Golov, 1933: 3 - 38). Some engorged nymphs overwintered in places which were not subject to flooding (Galuzo, 1941: 51 - 55). In the laboratory nymphs were able to survive without food for 9 to 27 days (Golov, 1933: 32 - 38).

The adults engorged in 7 to 16 days and copulation occurred on

the host. The males remained on the host longer and fed repeatedly (Golov, 1933: 32 - 38; Zasukhin, 1933: 31 - 46). Females engorged in the absence of males (Markov, et al., 1935: 106 - 109) and dropped from the host in mid-May to the beginning of June (Zasukhin, 1933: 31 - 46; Markov, et al., 1935: 106 - 109). Partially engorged ticks attached to new hosts (Golov, 1933: 32 - 38). When the adults appeared for the second time in the autumn the main mass overwintered in places which were not subject to flooding and did not usually feed until the following spring (Zasukhin, 1933: 31 - 46; Golov, 1933: 32 - 38; Galuzo, 1941: 51 - 55). Some adults, mostly males, overwintered on domestic animals (Galuzo, 1941: 51 - 55; Kasyanov, 1947: 14 - 15.

There was one generation a year (Pletzity, 1947: 877 - 878) and the cycle was completed in from 126 to 225 days, being favored by high humidity (Pogorely, 1936: 533 - 537; Golov, 1933: 32 - 38). In the laboratory where optimum conditions were available the cycle was completed in a minimum period of 82 days (Markov, et al., 1935: 106 - 109). At room temperature the adults survived up to 417 days (Golov, 1933: 32 - 38) and under winter conditions unfed adults lived for 5 1/2 months (Pogorely, 1936: 533 - 537).

Hosts of stages: Adult - zebu (Yakimov, et al., 1934 : 235 - 254), cattle (Golov, 1933: 32 - 38; Pospelova-Shtrom, 1935: 135 - 148; Pogorely, 1936: 533 - 537; Olenev and Kastrov, 1932: 28 - 30; Pletzity, 1947: 877 - 878; Orlov and Lonziger, 1938: 267 - 302; Kurchatov, 1940: 32; Zolotarev, 1934: 217 - 227; Skrynnik and Ryzhov, 1941: 41 - 49; Kasyanov, 1947: 14 - 15; Blagoveschensky, 1948: 83 - 113; Pomerantzev and Serdyukova, 1940: 336 - 337; Kurchatov, 1940: 26 - 29; Shpringgoltz-Shmidt, 135: 137 - 186; Karpov and Popov, 1944: 75 - 79; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 159 - 163), man (Golov, 1933: 32 - 38; Pogorely, 1936: 533 - 537; Antonov and Naishtat, 1937: 73 - 81; Zasukhin, 1937: 461 - 470; Shkorbatov, 1944: 43 - 46; Blagoveshchensky, 1948: 83 - 113; Pervomaisky, 1941: 81 - 94; Nelzina, 1945: 55 - 60; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 159 - 163), domestic animals (Galuzo, 1941: 51 - 55; Dubinin, 1948: 275 - 286; Zasukhin, 1937: 461 - 470; Zasukhin and Tikhomirova, 1937: 357 - 362; Nelzina, 1945: 55 - 60; Kochetkov, 1935: 124 - 127; Pomerantzev, 1946: 17, 18); goats (Pospelova-Shtrom, 1935: 135 - 148; Blagoveshchensky, 1948: 83 - 113; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), sheep (Pogorely, 1936: 533 - 537; Rastegaeva, 1937: 479 - 480; Olenev and Kastrov, 1932: 28 - 30; Zolotarev, 1934: 217 - 227; Kasyanov, 1947: 14 - 15; Blagoveshchensky, 1948: 83 - 113; Zasukhin, 1933, 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 159 - 163), horses (Pogorely, 1936: 533 - 537; Zasukhin, 1932: 181 -

185; Zasukhin, 1935: 261 - 264; Olenev, 1934: 367 - 388; Olenev and Kastrov, 1932: 28 - 30; Zasukhin, 1935: 1 - 159; Kurchatov and Sokolov, 1940: 35; Zolotarev, 1934: 217 - 227; Skrynnik and Ryzhov, 1941: 41 - 49; Kasyanov, 1947: 14 - 15; Blagoveshchensky, 1948: 83 - 113; Shpringgoltz-Shmidt, 1935; 137 - 186; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 159 - 163), swine (Pogorely, 1936: 533 - 537; Orlov and Lonziger, 1938: 287 - 302; Blagoveshchensky, 1948: 83 - 113; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), dogs (Pogorely, 1936: 533 - 537), (Zasukhin, 1935: 261 - 264; Skrynnik and Ryzhov, 1941: 41 - 49; Blagoveshchensky, 1948: 83 - 113; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 159 - 163), camels (Zasukhin, 1937: 461 - 470; Zasukhin and Tikhomirova, 1937: 357 - 362; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), reindeer (Kasyanov, 1947: 14 - 15), cat (Blagoveshchensky, 1948: 83 - 113; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), deer (Shpringgoltz-Shmidt, 1935: 137 - 186), Canis lupus (Shpringgoltz-Shmidt, 1935: 137 - 186; Zasukhin, 1935: 1 - 159; Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 159 - 163), Vulpes vulpes (Zasukhin, 1935: 1 - 159; Pomerantzev, 1946: 17, 18; Pomerantzev, 1950: 159 - 163), Manchurian deer, spotted deer (Pomerantzev, 1946: 17, 18), Cervus canadensis xanthopygus, Capreolus pygargus bedfordi, Cervus nippon hortulorum, Nyctereutes procyonoides, Tigris tigris amurensis, Lepus mantschuricus (Pomerantzev, 1950: 159 - 163).

Nymph and larva - Arvicola terrestris (Golov, 1933: 32 - 38), Microtus arvalis (Golov, 1933: 32 - 38; Zasukhin, 1935: 261 - 264; Zasukhin, 1935: 1 - 159), Hemiechinus auritus (Zasukhin, 1936: 219 - 226; Zasukhin, 1935: 261 - 264; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Lagurus lagurus (Zasukhin, 1935: 261 - 264; Zasukhin, 1935: 1 - 159), Alactaga jaculus (Zasukhin, 1935: 261 - 264; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Cricetus cricetus (Zasukhin, 1935: 261 - 264; Orlov, 1941: 45 - 47; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Citellus pygmaeus (Zasukhin, 1935: 261 - 264; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Apodemus agrarius (Zasukhin, 1935: 261 - 264; Zasukhin, 1935: 1 - 159), Apodemus sylvaticus (Zasukhin, 1935: 261 - 264; Zasukhin, 1935: 1 - 159), Arvicola amphibius (Zasukhin, 1935: 261 - 264; Zasukhin, 1935: 1 - 159), Mustela nivalis (Zasukhin, 1935: 261 - 264; Zasukhin, 1935: 1 - 159), Putorius eversmanni (Zasukhin, 1935: 261 - 264; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Erinaceus rumanicus (Zasukhin, 1935: 261 - 264; Zasukhin, 1936: 219 - 226; Zasukhin, 1936: 155 - 164), rodents (Pletzity, 1947: 877 - 878; Zasukhin and Tikhomirova, 1937: 357 - 362; Orlov and Lonziger, 1938: 287 - 302; Pomerantzev, 1946: 17, 18; Zasukhin, 1937: 461 - 470), Arvicola species (Za-

sukhin, 1937: 461 - 470), small mammals (Orlov, 1941: 45 - 47; Pomerantzev, 1946: 17, 18), Alactagulus acontion (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Citellus rufescens (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Citellus suslica, Mus musculus, Sorex species, Spalax microphthalamus, Lepus europaeus (Zasukhin, 1935: 1 - 159), birds (Pomerantzev, 1946: 17, 18).

Nymph - hares, Arvicola terrestris (Olsufiev and Golov, 1936: 187 - 226), dog, wolf, fox, horse, hedgehog (Pogorely, 1936: 533 - 537), cattle (Pogorely, 1936: 533 - 537; Zasukhin, 1933: 31 - 46), camel (Zasukhin, 1933: 31 - 46), Apodemus agrarius mantschuricus, Cricetulus nestor triton, Kolonocus sibiricus coreanus, Microtus michnoi pellicus, Citellus eversmanni (Pomerantzev, 1950: 159 - 163), Eutamias asiaticus orientalis, Rattus norvegicus caraco, Evotomys rufocanus, Lepus mantschuricus (Pomerantzev, 1950: 159 - 163; Blagoveshchensky, 1948: 83 - 113), Sciurus vulgaris, Apodemus speciosus praetor, Emberiza spodocephala extremi-orientis, field mouse, eastern field mouse, Kolonocus species (Blagoveshchensky, 1948: 83 - 113).

Larva - Cricetus cricetus, Citellus rufescens, Citellus pygmaeus, Putorius eversmanni (Zasukhin, 1933: 31 - 46), Apodemus agrarius mantschuricus, Citellus eversmanni (Pomerantzev, 1950: 159 - 163), Evotomys rufocanus, Eutamias asiaticus orientalis, Lepus mantschuricus (Pomerantzev, 1950: 159 - 163; Blagoveshchensky, 1948: 83 - 113), Sciurus vulgaris, Rattus norvegicus caraco, Apodemus speciosus praetor, Sorex species, Emberiza aureola ornata, Emberiza spodocephala extremi-orientis, Anthus hodgsoni, Phylloscopus fuscatus, Phragmaticola aëdon, Leuconotopicus minor amurensis, Capella megala, field mouse (Blagoveshchensky, 1948: 83 - 113).

Seasonal activity: In the lower Volga Region the adults appeared in the first half of April in the southern district and in the second half of April in the northern districts but in each case this varied with the character of the spring season (Zasukhin, 1933: 31 - 46). In some cases they appeared in the spring as early as the last few days of March (Zasukhin, 1932: 181 - 185; Zasukhin, 1935: 1 - 159). They occurred in maximum numbers from mid-April to early June and occasional specimens, usually males, extended into July and August. The adults appeared for the second time in the first half of July and became more abundant in August, September and October but only a small percentage of them fed during this period (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159). The larvae appeared in great numbers in the middle of June and the nymphs were most abundant in the second half of June and the first half of July (Zasukhin, 1933: 31 - 46). The larvae and nymphs were active from June to September (Zasukhin, 1935: 1 - 159; Zasukhin, 1936:

219 - 226).

In Kazakh S. S. R. the adults were active from March - May and reappeared in September. The larvae appeared in June and July and the nymphs in June - August (Golov, 1933: 32 - 38).

In Ukrainian S. S. R. the adults appeared in the first warm days of spring and the nymphs were active in the summer (Pogorely, 1936: 533 - 537). In Crimea the adults showed two periods of activity, one in the spring and the other in the autumn (Kurchatov, 1940: 32).

In Primor Territory the adults showed a double peaked curve of activity; one peak was in the spring-summer period (April - June) and the other in the fall-winter period (October - March). They were absent from July - September but were active again in the last days of September. However, they actually attached and fed only in the spring-summer period which was not a prolonged period for them. During the fall-winter period they remained on the host in an inactive state (Nelzina, 1945: 55 - 60). The larvae showed maximum numbers in July - August and the nymphs in July - mid-October (Pomerantzev, 1950: 159 - 163).

In Central Siberia the adults were active when the snow melted, usually toward the end of April and throughout May. Oviposition began at the end of May and the larvae hatched toward the end of June. The nymphs appeared in July and in the first half of August. The new generation of adults was active in the second half of August (Pletzity, 1947: 877 - 878).

In the Russian Far East adult activity also began when the snow melted but findings were rare in the south after May 10 (Pervomaisky, 1941: 81 - 94). In Khabarovsk Territory the adults were most abundant in the spring (Blagoveshchensky, 1948: 83 - 113) but had practically disappeared at the beginning of July (Skrynnik and Ryzhov, 1941: 41 - 49). The larvae were most prevalent at the beginning of July while the nymphs were most abundant at the end of the month (Blagoveshchensky, 1948: 83 - 113).

Habitats: All stages occurred in the forest zone (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Orlov and Lonziger, 1938: 287 - 302; Karpov and Popov, 1944: 75 - 79; Blagoveshchensky, 1948: 84 - 113); forest steppe zone (Olenev, 1931: 126 - 139; Kochetkov, 1935: 124 - 127; Zasukhin, 1935: 1 - 159; Galuzo, 1941: 51 - 55), dry steppe zone (Zasukhin, 1933: 31 - 46; Kochetkov, 1935: 124 - 127), steppe zone (Zasukhin, 1935: 1 - 159; Orlov and Lonziger, 1938: 287 - 302; Galuzo, 1949: 51 - 55; Karpov and Popov, 1944: 75 - 79; Pletzity, 1947: 46 - 51; Pletzity, 1947: 877 - 878), moule steppe zone (Zasukhin, 1933: 31 - 46), semi-desert zone (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), mountain pastures (Galuzo and Bespalov, 1935: 199 - 204), in

swampy country, lowlands, in areas cleared of forest (Mironov, 1938: 415 - 434) and in open hilly plains (Mironov, 1940: 93 - 105).

Control Measures

Solutions of sodium arsenite containing 0.2 and 0.24% As_2O_3 in which 0.5% kerosene was emulsified with 0.14% soap killed many of the ticks on rabbits. When the rabbits were treated 1 - 2 days after ticks were placed on them, 85% of the male ticks and 60 - 80% of the females were killed in 5 days. Of the surviving ticks 25% of the males and 10 - 40% of the females lived for 1 1/2 months, and 10% of the females laid viable eggs. The stronger solution was the more toxic. A cattle dip containing 0.16% As_2O_3 was not very effective (Kurchatov, 1940: 26 - 29).

Of several preparations tested against D. silvarum the only ones which gave complete mortality in 48 hours were K soap and 5% BHC dust. Though BHC and DDT dusts and suspensions of these chemicals were harmless to horses and rabbits, their use with soap and kerosene proved highly toxic (Egorov and Leontev, 1948: 35 - 37).

Relation to Disease

Tularemia: Adult ticks were found spontaneously infected in nature with B. tularense (Khatenever, 1942: 82 - 86; Karpov and Popov, 1944: 75 - 79) and though they were capable of passing the infection from one stage to the next (Zasukhin, 1937: 457 - 460) evidently transovarial transmisstion was not possible. The adults retained the infection for over 530 days (Zasukhin, 1937: 457 - 460).

Spring-summer Encephalitis: Though D. silvarum transmitted the virus of spring-summer encephalitis to man (Pavlovsky, 1939: 94 - 95; Pavlovsky, 1945: 65 - 92; Pomerantzev, 1950: 159 - 163) spontaneously infected individuals were rarely found (Levokovich, 1943: 49 - 53; Ryzhov and Kozlova, 1941: 34 - 40). It was experimentally infected and transmitted the disease (Pavlovsky, 1939: 94 - 95; Ryzhov and Skrynnik, 1939: 109 - 110; Pavlovsky, 1940: 58 - 71; Smorodintsev, 1940: 468 - 480). The virus was passed from stage to stage (Pavlovsky, 1939: 94 - 95; Ryzhov and Skrynnik, 1939: 109 - 110; Skrynnik and Ryzhov, 1941: 41 - 49) and through the egg (Smorodintsev, 1940: 468 - 480) to the next generation (Skrynnik and Ryzhov, 1941: 41 - 49). It was noticed, however, that females could only pass the virus on to their offspring when infected with massive doses of the virus (Levko-

vich, 1943: 49 - 53). Some individuals infected in the nymphal stage preserved the virus for 9 1/2 months (Pavlovsky, 1940: 58 - 71).

Adults that had acquired the virus in the nymphal stage were allowed to feed on healthy mice and the resistance of the mice was tested by injecting them with 2, 5 or 25 minimum lethal doses of the virus. Some mice proved resistant to the infection even with the highest dosages and their blood was found to contain antibodies which rendered the virus inactive. The degree of immunity varied with the number of ticks used per mouse and their duration of feeding (Levkovich and Skrynnik, 1941: 19 - 22).

Tick-borne Typhus: Rickettsiae were isolated from D. silvarum (Pletzity, 1947: 46 - 51) and it was regarded as a vector (Pavlovsky, 1947: 265 - 285; Savitskaya, 1943: 87; Pletzity, 1947: 877 - 878). The infection persisted in ticks from 1 generation to the next (Bocharova, 1943: 68 - 72). Guinea pigs were infected by the inoculation of eggs laid in the field and also by the bite of larva and nymphs (Bocharova, 1943: 68 - 72). Bites by ticks known to be infected do not always cause the creation of primary effects on guinea pigs for none were observed on rabbits on which infected and non-infected ticks had fed (Shkorbatov, 1944: 43 - 46).

Plague: The larvae sometimes harbored virulent plague bacilli for as long as 10 days and the nymphs retained it for 6 days (Zasukhin and Tikhomirova, 1937: 357 - 362) up to 35 days (Zasukhin, 1933: 31 - 46). However, in no case was transmission to subsequent stages accomplished. Over 60% of the nymphs and larvae died and possibly B. pestis was pathogenic to them. Since the ticks harbored the plague bacillus for such a short time and since they could not pass it on to the following stages it was concluded that D. silvarum did not infect rodents with plague (Zasukhin and Tikhomirova, 1937: 357 - 362).

Piroplasmosis: It was first regarded as a probable vector and was later proved to be the vector to horses of Babesia caballi (Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Olenev, 1934: 672 - 674; Markov, et al., 1935: 106 - 109; Zasukhin, 1935: 1 - 159; Zasukhin, 1935: 261 - 264; Pogorely, 1936: 533 - 537; Pomerantzev, 1950: 159 - 163), Babesia minor (Zasukhin, 1932: 181 - 185; Zasukhin, 1933; 277 - 282; Zasukhin, 1935: 1 - 159) and Babesia equi (Zasukhin, 1935: 1 - 195; Zasukhin, 1935: 261 - 264; Pomerantzev, 1950: 159 - 163). It was also found to be a vector of Babesia canis to dogs (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 261 - 264).

The larval or nymphal stage transmitted Babesia ninense to hedgehogs (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 261 - 264; Zasukhin, 1936: 155 - 164). The infective agent entered the intestine of the immature stages, developed to maturity in the adults, entered the

eggs, and then, through the bites of the subsequent immature stages infected hedgehogs. The adults were not directly involved in the transmission because they seldom fed on hedgehogs (Zasukhin, 1937: 457 - 460).

Anaplasmosis: Larvae from eggs laid by females taken on sheep infected with Anaplasma ovis and Theileria ovis were reared to the adult stage on mice and guinea pigs. The adults fed on a goat and 4 - 5 days later both species of parasites were observed in the peripheral blood (Rastegaeva, 1937: 479 - 480). A suspension of 10 females injected subcutaneously into a ram produced symptoms of acute anemia and weakness; 20 days later Anaplasma ovis was detected in the blood (Markov, 1941: 22 - 23).

Dermacentor variegatus kamshadalus Neumann

Dermacentor variegatus kamshadalus Neumann, 1908: 73 - 91.
Dermacentor variegatus var. kamtshadalus, Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1934: 367 - 388.
Dermacentor variegatus kamtschadalus, Olenev, 1931: 3 - 125; Shpringoltz-Shmidt, 1935: 137 - 186; Pomerantzev and Serdyukova, 1940: 336 - 337; Pomerantzev, 1946: 1 - 28; Pavlovsky, 1947: 160 - 201; Pomerantzev and Serdyukova, 1948: 47 - 67; Pomerantzev, 1950: 164.

Localities and Hosts

Kamchatka (Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1934: 367 - 388) on Ovis species (Neumann, 1908: 73 - 91; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 1 - 28; Pomerantzev and Serdyukova, 1948: 47 - 67; Pomerantzev, 1950: 164), deer (Olenev, 1928: 84 - 96), Rangifer tarandus (Shpringgoltz-Shmidt, 1935: 137 - 186). Far East (Pomerantzev and Serdyukova, 1940: 336 - 337; Pavlovsky, 1947: 160 - 201).

Biology

Host of stages: Only the male of the species was described.
Habitat: The male was found in the forest zone (Olenev, 1931: 126 - 129; Olenev, 1931: 3 - 125.

Haemaphysalis bispinosa Neumann

Haemaphysalis bispinosa Neumann, 1897: 341 - 342, 358; Warburton, 1908: 517 - 518; Nuttall and Warburton, 1915: 354, 360, 361, 426 - 433; Ogura and Takada, 1927: 204 - 205; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Sugimoto, 1936: 336; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Serdyukova, 1940: 336 - 337; Pospelova-Shtrom, 1945: 12 - 18; Pomerantzev, 1946: 13, 14; Pavlovsky, 1947: 160 - 201; Pomerantzev and Serdyukova, 1948: 47 - 67; Zhmaeva, 1950: 121 - 122; Anastos, 1950: 26 - 30; Traub, et al., 1954: 291 - 305.

Haemaphysalis neumanni Dönitz, 1905: 127 - 129, 134; Yakimov and Kohl-Yakimov, 1911: 418; Neumann, 1911: 106, 107, 109; Olenev, 1929: 305 - 314; Pomerantzev, 1950: 123 - 125.

Haemaphysalis bispinosa neumanni, Pospelova-Shtrom, 1939: 83.

Localities and Hosts

Asia

Japan - (Olenev, 1929: 305 - 314; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 13, 14; Pomerantzev, 1950: 123 - 125; Anastos, 1950: 26 - 30), on horse (Dönitz, 1905: 127 - 129, 134; Neumann, 1911: 109; Nuttall and Warburton, 1915: 426 - 433), cattle, dog (Dönitz, 1905: 127 - 129, 134; Neumann, 1911: 109); Tokyo, on cattle; Aomori, on horse; Daisen, on horse; Takanabe (Nuttall and Warburton, 1915: 426 - 433); Kyushu (Ogura and Takada, 1927: 204 - 205), on horse (Nuttall and Warburton, 1915: 426 - 433); Hokkaido (Ogura and Takada, 1927: 204 - 205). Formosa - (Sugimoto, 1936: 336; Anastos, 1950: 26 - 30). Korea - (Ogura and Takada, 1927: 204 - 205; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 13, 14; Pomerantzev, 1950: 123 - 125; Traub, et al., 1954: 291 - 305). China - (Anastos, 1950: 26 - 30), on cattle (Nuttall and Warburton, 1915: 426 - 433; Yakimov and Kohl-Yakimov, 1911: 418), Hydropotes inermis (Nuttall and Warburton, 1915: 426 - 433); Jehong, on Nemorhaedus cinereus; Fen Tuang Shan, An-Wei, on Cervulus species; Tsingtau, on dog (Nuttall and Warburton, 1915: 426 - 433).

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Russian Far East - (Pomerantzev and Serdyukova, 1940: 336 - 337; Pavlovsky, 1947: 160 - 201); southern part (Pospelova-Shtrom, 1936:

97 - 104). Primor Territory - (Pomerantzev, 1950: 123 - 125; Anastos, 1950: 26 - 30), on cattle (Yakimov and Kohl-Yakimov, 1911: 418; Nuttall and Warburton, 1915: 426 - 433); southern part (Pomerantzev, and Serdyukova, 1948: 47 - 67), on cattle (Zhmaeva, 1950: 121 - 122); Vladivostok (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139); Ussuri forest region (Pomerantzev, 1946: 13, 14).

On following hosts without definite indication of locality - horse, cattle, deer, badger, dog (Pomerantzev, 1950: 123 - 125).

Biology

Life history: In the laboratory eggs laid by females taken from cattle in Primor Territory gave rise to larvae and nymphs which fed on a rabbit in February and April, 1948. The resulting adults, all of which were females, refused to feed on a guinea pig in October but did so in April, 1949 and some required 13 days to complete their feeding. These females reproduced parthenogenetically and the eggs were viable. Embryonic development was slow and the eggs did not hatch for 6 weeks. Females from this generation were allowed to feed on a rabbit or a guinea pig in July, 1949 and engorged in 5 - 7 days and oviposition occurred 6 - 7 days later. Eggs laid by females that had fed on the rabbit required more than a month to hatch while those laid by females that had fed on guinea pigs began to hatch in 6 - 7 days. The larvae fed on a guinea pig for 3 - 4 days and moulted 10 - 14 days after dropping from the host. The nymphs engorged in four days, dropped off the host after 3 days and moulted 17 - 20 days later. Fecundity and viability were normal throughout all the experiments (Zhmaeva, 1950: 121 - 122).

Hosts of stages: Adults occurred on spotted deer, badger and dogs (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 123 - 125), domestic and wild mammals (Pomerantzev, 1946: 13, 14; Zhmaeva, 1950: 121 - 122; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 123 - 125), horses (Pomerantzev, 1950: 123 - 125). Immature stages were found on badger and dog (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 123 - 125).

Seasonal activity: All stages were found during the warm season from May to October (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 123 - 125).

Habitat: This species was found in the southern Ussuri type zone of forests (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 13, 14).

Haemaphysalis caucasica Olenev

Haemaphysalis caucasica Olenev, 1928: 29 - 34; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Kurchatov, 1940: 32; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 115 - 116; Melnikova, 1953: 422 - 434.

Localities and Hosts

Asia

Iran - Savelan Mountains, Muan (Olenev, 1928: 29 - 34; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 115 - 116).

U. S. S. R.

Kirghiz S. S. R. - Przheval'sk Province: Karakol, in vicinity of Issyk-Kul Lake (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 115 - 116). Ukrainian S. S. R. - (Pomerantzev, 1946: 1 - 28); Kherson Province: Askaniya Nova (Pomerantzev, 1950: 115 - 116). Tadzhik S. S. R. - Gissar Peaks (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 115 - 116); Crimean A. S. S. R. - (Kurchatov, 1940: 32); in valley of Alma River, on rabbit (Melnikova, 1953: 422 - 434). Daghestan A. S. S. R. - (Pomerantzev, 1950: 115 - 116). Transcaucasia - Zurnabad, on Lepus species (Olenev, 1928: 29 - 34; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 115 - 116).

On following hosts without definite indication of locality - hare, bear, jackal, fox, Eremias regeli and Eumeces schneideri (Pomerantzev, 1950: 115 - 116).

Biology

Host of stages: The adults occurred on hare, bear, jackal and fox. The nymphs were found on Eremias regeli and Eumeces schneideri

(Pomerantzev, 1950: 115 - 116).

Seasonal activity: Single findings were reported in March (Olenev, 1928: 29 - 34), April (Melnikova, 1953: 422 - 434), June (Olenev, 1928: 29 - 34) and July (Pospelova-Shtrom, 1936: 97 - 104).

Habitats: All stages were found in mountainous areas (Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104) and in river valleys (Melnikova, 1953: 422 - 434).

Haemaphysalis concinna Koch

Haemaphysalis concinna Koch, 1844: 237 - 238: Koch, 1847: 125; Neumann, 1897: 338 - 341; Nuttall and Warburton, 1915: 452 - 458, 542 - 545; Kotlán, 1919: 34 - 35; Yakimov, 1917: 298 - 301; Kotlán, 1921: 43 - 50; Olenev, 1928: 84 - 96; Olenev, 1928: 29 - 34; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Olenev, 1934: 367 - 388; Pospelova-Shtrom, 1935: 205 - 217; Shpringgoltz-Shmidt, 1935: 137 - 186; Pospelova-Shtrom, 1936: 97 - 104; Delpy, 1938: 1 - 10; Mironov, 1938: 415 - 434; Pavlovsky, 1939: 94 - 95; Pospelova-Shtrom, 1939: 85; Pomerantzev and Serdyukova, 1940: 336 - 337; Levkovich and Skrynnik, 1940: 118 - 121; Pavlovsky, 1940: 58 - 71; Pomerantzev and Matikashvili, 1940: 100 - 133; Blagoveshchensky, 1940: 15 - 17; Serdyukova and Khodakovsky, 1940: 17; Moskvin, 1940: 12 - 13; Kurchatov, 1940: 32; Mironov, 1940: 93 - 105; Smorodintsev, 1940: 468 - 480; Pavlovsky and Soloviev, 1940: 111 - 117; Pisyaukova, 1941: 65 - 80; Ryzhov and Kozlova, 1941: 34 - 40; Levkovich and Skrynnik, 1941: 19 - 22; Skrynnik and Ryzhov, 1941: 41 - 49; Ryzhov and Skrynnik, 1941: 27 - 33; Pervomaisky, 1941: 81 - 94; Pavlovsky and Soloviev, 1941: 9 - 18; Kozlova and Soloviev, 1941: 50 - 57; Zhmaeva, 1941: 14; Kozlova and Grachev, 1941: 17 - 19; Levkovich, 1943: 49 - 53; Savitskaya, 1943: 87; Bocharova, 1943: 6[illegible] - 7[illegible]; Gruzdev, 1943: 102 - 104; Shkorbatov, 1944: 43 - 46; Marikovsky, 1945: 60 - 66; Chumakov, et al., 1945: 18 - 24; Pavlovsky, 1945: 65 - 92; Nelzina, 1945: 55 - 60; Pomerantzev, 1946: [illegible] - 28; Pavlovsky, 1947: 160 - 201; Kasyanov, 1945: 14 - 15; Pletzity, 1947: 877 - 878; Pavlovsky, 1947: 265 - 285; Pervomaisky, 1947: 75 - 78; Zhmaeva and Korshunova, 1948: 287 - 289; Blagoveshchensky, 1948: 83 - 113; Pomerantzev and Serdyukova, 1948: 47 - 67; Pavlovsky, 1948: 582; Pomerantzev, 1950: 118 - 122; Melnikova, 1953: 422 - 434.

Haemaphysalis concinna concinna, Neumann, 1905: 239; Neumann, 1911: 110.

Haemaphysalis concinna kochi Neumann, 1905: 239; Neumann, 1911: 111; Nuttall and Warburton, 1915: 452 - 458; Olenev, 1929: 305 - 314.
Haemaphysalis hirudo Koch, 1887: 786; Neumann, 1897: 341.

Localities and Hosts

Europe

Europe - (Olenev, 1931: 126 - 139); central part (Pospelova-Shtrom, 1936: 97 - 104); western part (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 118 - 122). Austria - (Neumann, 1911: 110; Pomerantzev, 1950: 118 - 122). Balkan Peninsula - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 118 - 122). Germany - (Neumann, 1911: 110; Pomerantzev, 1950: 118 - 122); Brunswick (Nuttall and Warburton, 1915: 452 - 458). Hungary - (Kotlán, 1919: 34 - 35), on deer (Kotlán, 1921: 43 - 50). Poland - (Pomerantzev, 1950: 118 - 122), on deer (Neumann, 1911: 110; Nuttall and Warburton, 1915: 452 - 458).

Asia

Asia - eastern part (Olenev, 1931: 126 - 139; Pomerantzev, 1950: 118 - 122), southeastern part (Pomerantzev, 1946: 1 - 28), eastern and southeastern parts (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 118 - 122). Iran - (Pomerantzev, 1950: 118 - 122), on cattle, sheep and horses (Delpy, 1938: 1 - 10). Japan - (Neumann, 1911: 111; Olenev, 1931: 126 - 139; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 118 - 122); Saga, on dog (Neumann, 1905: 239). Korea - (Pavlovsky, 1947: 265 - 285); Honsan, Chaansa (Olenev, 1928: 29 - 34).

U. S. S. R.

Azerbaijan S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 118 - 122). Georgian S. S. R. - Lantshuty; Samtredi; Lagodekhi (Pomerantzev and Matikashvili, 1940: 100 - 133); western part (Pospelova-Shtrom, 1936: 97 - 104); central (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 118 - 122). Kazakh S. S. R. - Alma-Ata Province: Djarkent (Pospelova-Shtrom, 1936: 97 - 104); eastern part (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 118 - 122). Kirghiz S. S. R. - Issyk-Kul Province (Pomerantzev, 1950: 118 - 122). Uzbek S. S. R. - (Pomerantzev, 1946: 1 - 28); Samarkand Province: Samarkand (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 118 - 122).

R. S. F. S. R. - (Yakimov, 1917: 298 - 301); Irkutsk Province (Olenev, 1934: 367 - 388; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 118 - 122); Kemerovo Province (Pomerantzev, 1950: 118 - 122).

Khabarovsk Territory - (Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104; Pavlovsky, 1939: 94 - 95; Levkovich and Skrynnik, 1940: 118 - 121; Savitskaya, 1943: 87; Shkorbatov, 1944: 43 - 46; Pavlovsky, 1945: 65 - 92; Pavlovsky, 1947: 160 - 201; Pavlovsky, 1947: 265 - 285; Pomerantzev and Serdyukova, 1948: 47 - 67; Pomerantzev, 1950: 118 - 122), on Cervus hortulorum (Shpringgoltz-Shmidt, 1935: 137 - 186), cattle (Shpringgoltz-Shmidt, 1935: 137 - 186; Skrynnik and Ryzhov, 1941: 41 - 49; Pavlovsky and Soloviev, 1941: 9; Kozlova and Soloviev, 1941: 50 - 57), horses (Shpringgoltz-Shmidt, 1935: 137 - 186; Skrynnik and Ryzhov, 1941: 41 - 49; Kozlova and Soloviev, 1941: 50 - 57), small mammals (Shpringgoltz-Shmidt, 1935: 137 - 186), Erinaceus amurensis, Evotomys rufocanus (Pavlovsky, 1940: 58 - 71), dogs (Skrynnik and Ryzhov, 1941: 41 - 49; Ryzhov and Skrynnik, 1941: 27 - 33; Kozlova and Soloviev, 1941: 50 - 57), Sciurus vulgaris, Eutamias sibiricus (Kozlova and Soloviev, 1941: 50 - 57); southeastern and central parts (Kasyanov, 1947: 14 - 15); Khumary (Olenev, 1928: 29 - 34; Olenev, 1934: 367 - 388); Komsomolsk District, in vicinity of Lower Tambov, on Sciurus vulgaris, Eutamias asiaticus orientalis, Evotomys rufocanus, Emberiza aureola ornata, Emberiza spodocephala extremi-orientis, Alauda arvensis, Anthus hodgsoni, Poecile palustris crassirostris, Phragmaticola aëdon rufescens, Calliope calliope, Lynx torquilla, Capella megala, Milvus korschun lineatus, horses, cattle, dogs, Cervus canadensis, Sikka (Pseudaxis) hortulorum, Vulpes vulpes, Canis lupus, Nyctereutes procyonoides, Tigris tigris amurensis, Leopardus fontanieri, Prionailurus euptilura, Nyctereutes procyonoides, eastern field mice, groundhog (Blagoveshchensky, 1948: 83 - 112); Lower Amur (Blagoveshchensky, 1940: 15 - 17); Amur Valley (Pisyaukova, 1941: 65 - 80); Amur Province: (Neumann, 1911: 111); Blagoveshchensk (Olenev, 1934: 367 - 388; Olenev, 1928: 29 - 34); Tambovka, on Ovis aries (Olenev, 1928: 29 - 34); near Vatskov,; between Vatskov and Voronezhsky; vicinity of Malyshevskoe; Posetsky; Kedrovayapad (Olenev, 1928: 24 - 34).

Primor Territory - (Gruzdeva, 1943: 102 - 104; Marikovsky, 1945: 60 - 66; Pomerantzev, 1946: 1 - 28; Pletzity, 1947: 877 - 878; Zhmaeva and Korshunova, 1948: 287 - 289; Pomerantzev, 1950: 118 - 112), on wild and domestic animals and man (Nelzina, 1945: 55 - 60), Testrastes bonasia (Pervomaisky, 1947: 75 - 78); Sviashno (Olenev, 1928: 29 - 34); near Lake Khanka (Mironov, 1938: 415 - 434); Vladivostok, on dogs (Zhmaeva, 1941: 14), Sidemi, on dogs; Barabash Region (Pavlovsky, 1947:

265 - 285); Suputin Reservation (Pomerantzev and Serdyukova, 1940: 336 - 337; Kozlova and Grachev, 1941: 17 - 19); Ussuri Province (Moskvin, 1940: 12 - 13; Mironov, 1940: 93 - 105; Ryzhov and Kozlova, 1941: 34 - 40; Kozlova and Grachev, 1941: 17 - 19; Pervomaisky, 1941: 81 - 94).

Krasnodar Territory - (Pomerantzev, 1950: 118 - 122); Azov - Black Sea Region (Pospelova-Shtrom, 1936: 97 - 104). Stavropol Territory - (Pomerantzev, 1950: 118 - 122). Krasnoyarsk Territory - Western Sayan Mountains (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 118 - 122); northern slopes of Western Sayan Mountains (Serdyukova and Khodakovsky, 1940: 17).

Abkhazskaya A. S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104); Sukhumi, Gagry (Pomerantzev and Matikashvili, 1940: 100 - 133). Crimean A. S. S. R. - (Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104; Kurchatov, 1940: 32; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 118 - 122); Taushan Bazar (Olenev, 1928: 29 - 34); Crimean State Forest Reservation, on wild animals and cattle (Melnikova, 1953: 422 - 434). Daghestan A. S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 118 - 122). Birobidzhan Autonomous Region - (Pavlovsky, 1947: 265 - 285).

Caucasia - (Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28). Transcaucasia - (Pomerantzev, 1946: 1 - 28); western part (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 118 - 122); western part, in Kaldakhvary; Ekvili; Ozurgety; Gakhatura; Khidistavi; Nogomora; Gakhareuli; Bakhva; Likhouri; Khidilkovi, Sua; central part, in Aresh; Utushung; eastern part, in Gorovlu; on cattle, horse, buffalo, sheep, goat, dog, rodents, birds (Pomerantzev and Matikashvili, 1940: 100 - 133). Siberia - eastern part (Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Bocharova, 1943: 68 - 72; Pomerantzev, 1946: 1 - 28).

On following hosts without definite indication of locality - sheep (Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 118 - 122), rabbits (Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104), cattle (Pospelova-Shtrom, 1936: 97 - 104; Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122), goats (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 118 - 122), horses (Pospelova-Shtrom, 1936: 97 - 104; Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122), buffalo (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 118 - 122), spotted deer (Pospelova-Shtrom, 1936: 97 - 104; Pavlovsky, 1947: 265 - 285), dog (Pospelova-Shtrom, 1936: 97 - 104; Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122), hedgehog (Pospelova-Shtrom, 1936: 97 - 104; Pavlovsky, 1947:

265 - 285), man (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 118 - 122), small rodents (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28), birds (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 118 - 122), reptiles (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 118 - 122), domestic animals (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 118 - 122), wild ungulates (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 118 - 122), Cervus elaphus xanthopygus, Capreolus capreolus, Felis pardus, Nyctereutes procyonoides, Meles meles, Far Eastern forest cat, chipmunk, squirrel, mole, raven, magpie, hazel hen, yellow hammer, starling, nightingale, sparrow (Pavlovsky, 1947: 265 - 285), hare, field mice, wood mice, rat, badger (Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122), zebu, deer, wolf (Pomerantzev, 1950: 118 - 122).

Biology

Life history: In the laboratory the pre-oviposition period varied from 4 to 19 days (Kozlova and Soloviev, 1941: 50 - 57; Shpringoltz-Shmidt, 1935: 137 - 186; Pomerantzev, 1950: 122). The egg laying period lasted from 30 to 32 days and from 1000 to 5000 eggs were deposited (Shpringgoltz-Shmidt, 1935: 137 - 186; Pomerantzev, 1950: 122). The egg stage lasted 16 to 56 days (Shpringgoltz-Shmidt, 1935: 137 - 186; Kozlova and Soloviev, 1941: 50 - 57; Pomerantzev, 1950: 122) and humid or dry conditions had no effect upon the eggs (Shpringoltz-Shmidt, 1935: 137 - 186).

In a humid insectary the larvae withstood starvation for 6 months but in a dry one they survived somewhat over 4 months. The activity of the larvae increased with a rise in temperature but 47° C. was fatal to them (Shpringgoltz-Shmidt, 1935: 137 - 186). The larvae fed in 3 to 13 days (Shpringgoltz-Shmidt, 1935: 137 - 186; Pomerantzev, 1950: 122) and after engorgement the larval stage lasted 16 - 25 days (Shpringgoltz-Shmidt, 1935: 137 - 186; Kozlova and Soloviev, 1941: 50 - 57).

After engorgement the nymphal stage lasted 22 to 55 days (Shpringoltz-Shmidt, 1935: 137 - 186; Kozlova and Soloviev, 1941: 50 - 57; Pomerantzev, 1950: 122). The females fed in 8 to 16 or more days (Pomerantzev, 1950: 122). The complete life cycle in the laboratory lasted from 100 - 475 days (Shpringgoltz-Shmidt, 1935: 137 - 186; Pomerantzev, 1950: 122).

Under natural conditions the female engorged in 10 to 20 days

and then dropped to the ground where they oviposited in places sheltered from the direct rays of the sun. The larvae hatched in about a month and crawled on to grass stems where they sometimes waited as long as 180 days for a host (Shpringgoltz-Shmidt, 1935: 137 - 186). The cycle under these conditions lasted from one and a half to two years (Pomerantzev, 1950: 122).

Hosts of stages: Adult - sheep (Neumann, 1911: 110; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 118 - 122; Blagoveshchensky, 1948: 83 - 113), deer (Neumann, 1911: 110; Olenev, 1928: 84 - 96; Pomerantzev, 1950: 118 - 122), dog (Olenev, 1928: 84 - 96; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Skrynnik and Ryzhov, 1941: 41 - 49; Kozlova and Soloviev, 1941: 50 - 57; Zhmaeva, 1941: 14; Pomerantzev, 1950: 118 - 122; Blagoveshchensky, 1948: 83 - 113), rabbit (Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104; Cervus hortulorum (Shpringgoltz-Shmidt, 1935: 137 - 186), domestic animals (Pospelova-Shtrom, 1936: 97 - 104; Blagoveshchensky, 1940: 15 - 17; Pomerantzev, 1946: 1 - 28; Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122), wild mammals (Pospelova-Shtrom, 1936: 97 - 104; Blagoveshchensky, 1940: 15 - 17; Pomerantzev, 1946: 1 - 28; Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122), cattle (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Skrynnik and Ryzhov, 1941: 41 - 49; Kozlova and Soloviev, 1941: 50 - 57; Zhmaeva, 1941: 14; Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122; Blagoveshchensky, 1948: 83 - 113), goats (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Blagoveshchensky, 1948: 83 - 133; Pomerantzev, 1950: 118 - 122), horses (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Skrynnik and Ryzhov, 1941: 41 - 49; Kozlova and Soloviev, 1941: 50 - 57; Zhmaeva, 1941: 14; Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122; Blagoveshchensky, 1948: 83 - 113), buffalo (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 118 - 122), spotted deer (Pospelova-Shtrom, 1936: 97 - 104), hedgehogs (Pospelova-Shtrom, 1936: 97 - 104; Pavlovsky, 1947: 265 - 285; Blagoveshchensky, 1948: 83 - 113), man (Pospelova-Shtrom, 1936: 97 - 104; Pervomaisky, 1941: 81 - 94; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 118 - 122; Blagoveshchensky, 1948: 83 - 113), rodents (Pomerantzev, 1946: 1 - 28), Cervus elaphus xanthopygus, Capreolus capreolus, Felis pardus, Far Eastern forest cat (Pavlovsky, 1947: 265 - 285), hare (Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122; Blagoveshchensky, 1948:

83 - 113), zebu, bear, badger (Pomerantzev, 1950: 118 - 122), wolf (Pomerantzev, 1950: 118 - 122; Blagoveshchensky, 1948: 83 - 113), Cervus canadensis, Sikka (Pseudaxis) hortulorum, Vulpes vulpes, Tigris tigris amurensis, Leopardus pardus fontanieri, Prionailurus euptilura, groundhog (Blagoveshchensky, 1948: 83 - 113), Nyctereutes procyonoides (Pavlovsky, 1947: 265 - 285; Blagoveshchensky, 1948: 83 - 113).

Nymph and larva - Cervus hortulorum (Shpringgoltz-Shmidt, 1935: 137 - 186), small mammals (Shpringgoltz-Shmidt, 1935: 137 - 186; Pospelova-Shtrom, 1936: 97 - 104; Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122), birds (Shpringgoltz-Shmidt, 1935: 137 - 186; Pospelova-Shtrom, 1936: 97 - 104; Moskvin, 1940: 12 - 13; Blagoveshchensky, 1940: 15 - 17; Pomerantzev, 1946: 1 - 28; Pavlovsky, 1947: 265 - 285; Blagoveshchensky, 1948: 83 - 113; Pomerantzev, 1950: 118 - 122), reptiles (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 118 - 122), cattle (Pomerantzev and Matikashvili, 1940: 100 - 133; Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122; Blagoveshchensky, 1948: 83 - 113), rodents (Blagoveshchensky, 1940: 15 - 17; Zhmaeva, 1941: 14; Pomerantzev, 1946: 1 - 28; Blagoveshchensky, 1948: 83 - 113), Sciurus vulgaris (Kozlova and Soloviev, 1941: 50 - 57; Blagoveshchensky, 1948: 83 - 113), Eutamias sibiricus (Kozlova and Soloviev, 1941: 50 - 57), chipmunk, squirrel, mole, spotted deer (Pavlovsky, 1947: 265 - 285) field mouse, wood mouse, rat (Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122), hare (Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122; Blagoveshchensky, 1948: 83 - 113), badger (Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122), large mammals, sheep, horse, deer, (Pomerantzev, 1950: 118 - 122), Eutamias asiaticus orientalis, Evotomys rufocanus, Emberiza aureola ornata, Emberiza spodocephala extremi-orientis, Alauda arvensis, Anthus hodgsoni, Poecile palustris crassirostris, Phragmaticola aëdon rufescens, Calliope calliope, Lynx torquilla, Capella megala, Milvus korschun lineatus, Cervus canadensis, Sikka (Pseudaxis) hortulorum, hedgehog, Vulpes vulpes, Canis lupus, Nyctereutes procyonoides, Tigris tigris amurensis, eastern field mouse, groundhog (Blagoveshchensky, 1948: 83 - 113), dog (Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 118 - 122; Blagoveshchensky, 1948: 83 - 113).

Nymph - man (Pomerantzev, 1950: 118 - 122; Kozlova and Soloviev, 1941: 50 - 57), sheep (Pomerantzev and Matikashvili, 1940: 100 - 133).

Larva - rodents, birds (Pomerantzev and Matikashvili, 1940: 100 - 133).

Seasonal activity: In the U. S. S. R. the adults showed a single peak of activity from March to September with maximum abundance in

June. The larvae and nymphs were active from March to November. The nymphs were found in greatest numbers in June - August and the larvae showed a peak of abundance in the second half of June and July (Pomerantzev, 1950: 118 - 122; Shpringgoltz-Shmidt, 1935: 137 - 186; Levkovich and Skrynnik, 1940: 118 - 121; Pervomaisky, 1941: 81 - 94; Kozlova and Soloviev, 1941: 50 - 57; Zhmaeva, 1941: 14; Nelzina, 1945: 55 - 60; Blagoveshchensky, 1948: 83 - 113; Pomerantzev and Matikashvili, 1940: 100 - 133; Melnikova, 1953: 422 - 434).

Habitats: All stages appeared to be exclusively connected to forest zones of various types (Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104; Mironov, 1938: 415 - 434; Levkovich and Skrynnik, 1940: 118 - 121; Pomerantzev and Matikashvili, 1940: 100 - 133; Mironov, 1940: 93 - 105; Pervomaisky, 1941: 81 - 94; Kasyanov, 1947: 14 - 15; Blagoveshchensky, 1948: 83 - 113) though they were also found in mountainous regions (Serdyukova and Khodakovsky, 1940: 17; Olenev, 1931: 3 - 125). Characteristic habitats were damp areas such as drying, hillocky marshes covered with grassy vegetation and shrubs (Zhmaeva, 1941: 14).

Parasites: A number of Hunterellus hookeri was obtained from a nymph (Pervomaisky, 1947: 75 - 78).

Relation to Disease

Spring-Summer Encephalitis: H. concinna was a natural and an experimental vector of this disease (Smorodintsev, 1940: 468 - 480; Pavlovsky and Soloviev, 1940: 111 - 117; Kozlova and Soloviev, 1941: 50 - 57; Chumakov, et al., 1945: 18 - 24; Pavlovsky, 1945: 65 - 92; Pavlovsky, 1947: 160 - 201; Pomerantzev, 1950: 118 - 122). Though this species ranked after Ixodes persulcatus and Dermacentor silvarum in importance as a vector (Pavlovsky, 1945: 65 - 92), it probably was of importance in maintaining the virus among wild animals and birds (Chumakov, et al., 1945: 18 - 24).

In experiments with suspensions of different organs of H. concinna it was found that the virus circulated in the body of the tick and that it concentrated in the salivary glands. Transmission of the virus occurred through the salivary glands (Pavlovsky, 1939: 94 - 95; Pavlovsky and Soloviev, 1940: 111 - 117). In other experiments where ticks were allowed to feed partially or completely on infected mice it was found that the virus persisted in the intestine for at least 6 days. In those which had partially engorged the virus was present in an inapparent form, that is, its presence was shown only by subinoculation and the virus was demonstrated only in the intestine and in the sali-

vary glands. In the ticks which had completely engorged the virus was demonstrated in the apparent form in the intestine and in the salivary gland and in the inapparent form in the haemolymph, Malpighian tubules, genitalia, Gene's organ and the central nervous system.

The adults transmitted the infection to the eggs (Smorodintsev, 1940: 468 - 480) through the walls of the ovary (Pavlovsky and Soloviev, 1940: 111 - 117). Adults only transmitted the virus to their offspring when they had been infected with massive doses of the virus (Levkovich, 1943: 49 - 53). Ticks which had acquired the virus in the larval stage by feeding on infected mice transmitted the infection in the nymphal stage when fed on healthy mice and they also passed the virus on to the adult stage (Kozlova and Soloviev, 1941: 50 - 57).

Tick-borne Typhus: H. concinna transmitted this disease (Savitskaya, 1943: 87; Bocharova, 1943: 68 - 72; Pletzity, 1947: 877 - 878; Pomerantzev, 1950: 118 - 122; Zhmaeva and Korshunova, 1948: 287 - 289; Pavlovsky, 1947: 265 - 285). Naturally infected ticks were found and the rickettsiae were passed from rodent to rodent and to man by nymphs and adults (Pavlovsky, 1947: 265 - 285).

Larvae which were fed on infected guinea pigs transmitted the disease to healthy guinea pigs on which they fed as nymphs and to others on which they fed as adults 11 months after the last molt (Zhmaeva and Korshunova, 1948: 287 - 289).

Haemaphysalis inermis Birula

Haemaphysalis inermis Birula, 1895: 360; Neumann, 1901: 264; Neumann, 1911: 116; Nuttall and Warburton, 1915: 362 - 369, 545 - 547; Knuth, et al., 1918: 241 - 264; Olenev, 1928: 84 - 96; Olenev, 1928: 29 - 34; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Yakimov, et al., 1934: 235 - 254; Zolotarev, 1934: 217 - 227; Pospelova-Shtrom, 1936: 97 - 104; Oswald, 1937: 265 - 273; Delpy, 1938: 1 - 10; Pospelova-Shtrom, 1939: 73; Pomerantzev and Matikashvili, 1940: 100 - 133; Kurchatov, 1940: 32; Pavlov, 1942: 227 - 232; Pospelova-Shtrom, 1945: 12 - 18; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 95 - 97; Melnikova, 1953: 422 - 434.

Haemaphysalis ambigua Neumann, 1901: 262; Neumann, 1906: 217; Neumann, 1911: 109; Nuttall and Warburton, 1915: 362; Olenev, 1929: 305 - 314.

Localities and Hosts

Europe

Europe - southern part (Olenev, 1931: 126 - 139); western part (Pomerantzev, 1946: 1 - 28; eastern part (Pomerantzev, 1950: 95 - 97). Macedonia - on horses (Knuth, et al., 1918: 241 - 264). Bulgaria - on goats (Pavlov, 1942: 227 - 232). Balkan Peninsula - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 95 - 97). Jugoslavia (Oswald, 1937: 265 - 273).

Asia

Iran - (Pomerantzev, 1950: 95 - 97), on sheep (Delpy, 1938: 1 - 10).

U. S. S. R.

U. S. S. R. - Azov-Black Sea Area (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 95 - 97). Caucasia (Birula, 1895: 360; Neumann, 1911: 116; Nuttall and Warburton, 1915: 362 - 369; Olenev, 1928: 84 - 96; Olenev, 1931: 126 - 139; Olenev, 1929: 305 - 314; Pomerantzev, 1946: 1 - 28), on cattle (Olenev, 1931: 3 - 125); North Caucasus (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 95 - 97). Transcaucasus (Pomerantzev and Matikashvili, 1940: 100 - 133); Surnabad (Olenev, 1928: 29 - 34), on cattle and fox (Nuttall and Warburton, 1915: 362 - 369; Olenev, 1928: 84 - 96; Olenev, 1928: 29 - 34); Karasu in Geoktshai District, on cattle (Olenev, 1928: 29 - 34). Georgian S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104); central and eastern parts (Pomerantzev, 1950: 95- 97). Armenian S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104). Azerbaijan S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 95 - 97), on zebu (Yakimov, et al., 1934: 235 - 254). Moldavian S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 95 - 97). R. S. F. S. R. - Grozny Province: Kizlyar (Olenev, 1928: 29 - 34). Daghestan A. S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 95 - 97), on cattle, sheep, dogs (Zolotarev, 1934: 217 - 227). Crimean A. S. S. R. - (Kurchatov, 1940: 32), on cattle, rabbit, deer (Melnikova, 1953: 422 - 434). Abkhazskaya A. S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104). Krasnodar Territory, in vicinity of Novorossiysk (Olenev, 1928: 29 - 34). Turkestan (Olenev, 1928: 84 - 96).

On following hosts without definite indication of locality:

cattle (Olenev, 1928: 84 - 96; Pospelova-Shtrom, 1936: 97 - 104); sheep, goats, zebu, horses, dogs (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 95 - 97), wild goats, Apodemus sylvaticus (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28), man (Pospelova-Shtrom, 1936: 97 - 104), domestic animals, deer, fox (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 95 - 97), buffalo and wood mouse (Pomerantzev, 1950: 95 - 97).

Biology

Life history: H. inermis required three hosts to complete its development. The young stages were rarely found on their host owing to their rapid engorgement.

Hosts of stages: Adult - cattle (Nuttall and Warburton, 1915: 362 - 369; Olenev, 1928: 84 - 96; Olenev, 1928: 29 - 34; Olenev: 1931: 3 - 125; Zolotarev, 1934: 217 - 227; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Melnikova, 1953: 422 - 434), fox (Nuttall and Warburton, 1915: 362 - 369; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 95 - 97), horses (Knuth, et al., 1918: 241 - 264; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 95 - 97), zebu (Yakimov, et al., 1934: 235 - 254; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 95 - 97), sheep (Zolotarev, 1934: 217 - 227; Pospelova-Shtrom, 1936: 97 - 104; Delpy, 1938: 1 - 10; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 95 - 97), dogs (Zolotarev, 1934: 217 - 227; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 95 - 97), goats (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pavlov, 1942: 227 - 232; Pomerantzev, 1950: 95 - 97), wild goats (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28), man (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 95 - 97), buffalo (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 95 - 97), domestic animals, deer (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 95 - 97).

Immature stages - Apodemus sylvaticus (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 95 - 97). Larva - rabbit. Nymph - deer (Melnikova, 1953: 422 - 434).

Seasonal activity: In Transcaucasia the adults occurred from September to April but occasional adults were found in the summer months; the larvae and nymphs were found from June to September (Pomerantzev and Matikashvili, 1940: 100 - 133). In Crimea semi-mature forms were found in April, October, November, December on domestic

animals and in April, December and February on deer (Melnikova, 1953: 422 - 434).

Habitats: All stages were found in the forest belt of the semi-desert zone and near the mountainous semi-desert zone (Pomerantzev and Matikashvili, 1940: 100 - 133; Kurchatov, 1940: 32; Olenev, 1931: 3 - 125). Though they were restricted mainly to the zone of broad-leafed and mixed forests in steppes and in mountains they were also found in secondary vegetation (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 95 - 97). This species rarely reached the steppe zone (Pomerantzev and Matikashvili, 1940: 100 - 133).

Relation to Disease

H. inermis was found to cause tick paralysis in the Wratza District of Bulgaria and the mortality in untreated animals reached 25 - 50% (Pavlov, 1942: 227 - 232). It was regarded as a possible agent of tick paralysis in the U. S. S. R. (Pomerantzev, 1950: 95 - 97).

Haemaphysalis otophila Schulze

Haemaphysalis otophila Schulze, 1918: 64; Knuth, et al., 1918: 241 - 264; Kotlán, 1921: 43 - 50; Pospelova-Shtrom, 1935: 247; Pospelova-Shtrom, 1936: 97 - 104; Pospelova-Shtrom, 1939: 91; Pomerantzev and Matikashvili, 1940: 100 - 133; Kurchatov, 1940: 32; Kurchatov, 1940: 26 - 29; Kurchatov, 1941: 97 - 103; Markov, 1941: 22 - 23; Pospelov-Shtrom, 1945: 12 - 18; Pomerantzev, 1946: 1 - 28; Nikolsky, 1948: 29 - 33; Pomerantzev, 1950: 108 - 111; Melnikova, 1953: 422 - 434.

Haemaphysalis cinnabarina v. punctata, Nuttall and Warburton, 1915: 384 in part.

Haemaphysalis sulcata otophila Schulze, 1927: 114, in part; Olenev, 1929: 489 - 494.

Haemaphysalis sulcata, Olenev, 1928: 29 - 34; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Belavin and Nikolsky, 1937: 138.

Localities and Hosts

Europe

Macedonia - on horse (Knuth, et al., 1918: 6 - 12). Hungary - on cattle and horses (Kotlán, 1921: 43 - 50). Balkan Peninsula (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 108 - 111).

Asia

Asia Minor - Angora (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 108 - 111).

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Ukrainian S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 108 - 111); southern part (Pomerantzev, 1946: 1 - 28). Turkmen S. S. R. - (Pomerantzev, 1946: 1 - 28); Kara-Kala (Pospelova-Shtrom, 1936: 97 - 104); western part (Markov, 1941: 22 - 23; Pomerantzev, 1950: 108 - 111). Georgian S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104). Armenian S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104). Azerbaijan S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Kurchatov, 1941: 97 - 103). Crimean A. S. S. R. - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pospelova-Shtrom, 1936: 97 - 104; Kurchatov, 1940: 32; Markov, 1941: 22 - 23; Pomerantzev, 1946: 1 - 28), on cattle and deer (Melnikova, 1953: 422 - 434); Salgirka (Olenev, 1928: 29 - 34). Daghestan A. S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 108 - 111); Dashlagar (Olenev, 1928: 29 - 34); Zurnabad on Lepus species (Olenev, 1928: 29 - 34); Stavropol Territory - (Kurchatov, 1940: 26 - 29), on sheep (Markov, 1941: 22 - 23), cattle (Nikolsky, 1948: 29 - 33). Caucasia - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Markov, 1941: 22 - 23; Pomerantzev, 1946: 1 - 28); Kuban (?) 25 km. from St. Krymska, on Lepus species (Olenev, 1928: 29 - 34); northern part (Pospelova-Shtrom, 1936: 97 - 104). Ciscaucasia - (Pomerantzev, 1950: 108 - 111). Transcaucasia - (Olenev, 1928: 84 - 96); central part (Pomerantzev and Matikashvili, 1940: 100 - 133); eastern part (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 108 - 111); western part, along Black Sea Shore (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 108 - 111; Pospelova-Shtrom, 1936: 97 - 104). Nakhichevanskaya

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A. S. S. R. - Nakhitshevan, on Ovis aries (Olenev, 1928: 29 - 34). Azov-Black Sea Area - (Pospelova-Shtrom, 1936: 97 - 104).

On following hosts without definite indication of locality: domestic animals (Pomerantzev, 1946: 1 - 28), rabbit (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 108 - 111; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), man (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 108 - 111), birds (Pomerantzev, 1946: 1 - 28; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111), reptiles (Pomerantzev, 1946: 1 - 28; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 108 - 111), cattle (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111), sheep (Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111), goats (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111), horses (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111), buffalo (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111), donkeys (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 108 - 111), camel (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 108 - 111), dog (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111), Melanocorypha calandra (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 108 - 111), birds (Pomerantzev, 1950: 108 - 111; Pomerantzev and Matikashvili, 1940: 100 - 133), Lacerta taurica (Pospelova-Shtrom, 1936: 97 - 104), Lacerta agilis (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 108 - 111); hedgehog (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 108 - 111), Cricetulus nigricans (Pospelova-Shtrom, 1936: 97 - 104), hare (Pomerantzev, 1950: 108 - 111; Pomerantzev and Matikashvili, 1940: 100 - 133), lizards (Pomerantzev and Matikashvili, 1940: 100 - 133).

Biology

Life history: Under laboratory conditions oviposition began 3 to 49 days after engorgement and lasted 12 to 20 days with about 3000 eggs deposited. The larvae hatched in 25 to 36 days after the eggs were laid and completed engorgement in 2 to 7 days. The resting period before transformation into the nymphal stage was 15 to 28 days. Some larvae survived without feeding for 3 to 8 months. The nymphs engorged in 2 to 8 days and required 17 to 26 days after feeding to molt into the

adult stage. Unfed nymphs survived for 50 days to 2 1/2 months. The female engorged in 3 to 14 days and lived for 5 to 30 days after the completion of oviposition. Unfed adults lived six months. The cycle was completed within 50 to 84 days (Pomerantzev, 1950: 110).

Hosts of stages: Adult - horse (Knuth, et al., 1918: 241 - 264; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111; Kotlán, 1921: 43 - 50), cattle (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111; Kotlán, 1921: 43 - 50), sheep (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Olenev, 1928: 29 - 34), goats (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111), buffalo (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111), dogs (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111), hares (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111), domestic animals (Pomerantzev, 1946: 1 - 28), rabbit (Pomerantzev, 1946: 1 - 28; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), man (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 108 - 111), donkey, camel (Pomerantzev, 1950: 108 - 111), Lepus species (Olenev, 1928: 29 - 34).

Immature stages - Melanocorypha calandra (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 108 - 111), Lacerta taurica (Pospelova-Shtrom, 1936: 97 - 104), Lacerta agilis (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 108 - 111), rabbit (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 108 - 111), hedgehog (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 108 - 111), Cricetulus nigricans (Pospelova-Shtrom, 1936: 97 - 104), lizards (Pomerantzev and Matikashvili, 1940: 100 - 133), birds (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 108 - 111), sheep (Pomerantzev and Matikashvili, 1940: 100 - 133), cattle (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111), reptiles (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 108 - 111), hares, goats, man (Pomerantzev, 1950: 108 - 111).

Seasonal activity: In Transcaucasia the adults showed their maximum abundance during the autumn-winter-spring period, from August to March (Pomerantzev and Matikashvili, 1940: 100 - 133). Immature forms were found from March to August (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 108 - 111).

Habitats: All stages were found in the steppe zone (Pospelova-Shtrom, 1936: 97 - 104; Kurchatov, 1940: 32; Olenev, 1931: 3 - 125), in the mountain steppe zone, in the mountain forest zone (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133), secondary pastures of the forest zone (Pospelova-Shtrom, 1936: 97 -

104), in the semi-steppe zone, in the semi-desert zone (Pomerantzev and Matikashvili, 1940: 100 - 133) and in the forest steppe zone (Kurchatov, 1940: 32; Olenev, 1931: 3 - 125). It was not well adapted to the semi-desert conditions as shown by its distribution (Pomerantzev and Matikashvili, 1940: 100 - 133).

Control Measures

A dip containing 0.16% As_2O_3 when used on cattle at intervals of 5 days was not very effective (Kurchatov, 1940: 26 - 29). Larvae which were heavily dusted with DDT became inactive in 5 hours while those dusted with BHC became inactive in 3 hours. Larvae immersed for one minute in 0.01 to 0.5% suspensions of BHC were immobilized in 60 minutes by 0.1 or 0.5% but 10 - 13% survived the 0.01% suspension. The larvae were affected by all concentrations of DDT. All adults were killed by BHC and DDT dusts. A. 0.5% suspension of BHC applied in September-October freed calves from a heavy infestation of ticks (Nikolsky, 1948: 29 - 33). In tests with pyrethrum this species was the least resistant of several exposed (Kurchatov, 1941: 97 - 103).

Relation to Disease

Diseases: When adults of H. otophila were taken from sheep and placed on a ewe Babesia ovis appeared in the blood 8 days later. Outbreaks of the disease have been observed in the autumn-winter season when sheep were often infested by this species but were free of other tick species (Markov, 1941: 22 - 23).

Haemaphysalis numidiana taurica Pospelova-Shtrom

Haemaphysalis numidiana taurica Pospelova-Shtrom, in Pomerantzev and Matikashvili, 1940: 100 - 133; in Pomerantzev, 1946: 13 (Key to species); in Pomerantzev, 1950: 113.

Haemaphysalis numidiana, Olenev, 1928: 84 - 96, in part; Olenev, 1928: 29 - 34, in part; Olenev, 1929: 305 - 314, in part; Olenev, 1931: 126 - 139, in part; Olenev, 1931: 3 - 125, in part; Pospelova-Shtrom, 1936: 97 - 104; Kurchatov, 1940: 32.

Localities and Hosts

Asia

Iran - northern part (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 13; Pomerantzev, 1950: 113).

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Crimean A. S. S. R. - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104; Kurchatov, 1940: 32); southern part (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 13; Pomerantzev, 1950: 113); Biuk-Lambat, on Erinaceus europaeus rumanicus (Olenev, 1928: 29 - 34). Daghestan A. S. S. R. - (Pomerantzev, 1950: 113); Kuban region (Pospelova-Shtrom, 1936: 97 - 104). Armenian S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 13; Pomerantzev, 1950: 113). North Caucasus - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 113). Transcaucasus - (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 113).

On following hosts without definite indication of locality: Erinaceus europaeus, Mustela foina (Pospelova-Shtrom, 1936: 97 - 104), bear, birds (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 13), small burrowning mammals (Pomerantzev, 1946: 13).

Biology

Hosts of stages: All stages were found mostly on small mammals living in lairs (Pospelova-Shtrom, 1936: 97 - 104).

Seasonal activity: Adults were found more frequently from April to October, but some were collected in December - January. Immature forms were taken from September - January but nymphs were found sometimes in May - June and larvae in July (Pospelova-Shtrom, 1936: 97 - 104).

Habitats: All stages were adapted to life in closed biotopes such as caves and especially in lairs of their hosts and were found in the steppe zone and in secondary xerophytic vegetation of the mountain forest zone (Pospelova-Shtrom, 1936: 97 - 104).

Haemaphysalis numidiana turanica Pospelova-Shtrom

Haemaphysalis numidiana turanica Pospelova-Shtrom in Pomerantzev, 1946: 13 (Key to species); in Pomerantzev, 1950: 114 - 115.
Haemaphysalis numidiana, Olenev, 1928: 84 - 96, in part; Olenev, 1928: 29 - 34, in part; Olenev, 1928: 305 - 314, in part; Olenev, 1930: 604 - 610; Olenev, 1931: 126 - 139, in part; Olenev, 1931: 3 - 125, in part; Zasukhin, 1933: 31 - 46; Zasukhin and Tiflov, 1933: 437 - 442; Olenev, 1934: 367 - 388; Zasukhin, 1935: 1 - 159; Pospelova-Shtrom, 1936: 115 - 134; Zasukhin, 1936: 219 - 226; Zasukhin, 1936: 155 - 164; Pospelova-Shtrom, 1936: 97 - 104, in part: eastern type; Pomerantzev and Matikashvili, 1940: 100 - 133.

Localities and Hosts

Central Asia - (Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125), on Erinaceus species (Olenev, 1928: 29 - 34), small burrowing animals (Pomerantzev, 1946: 13). Turkestan - (Olenev, 1928: 84 - 96). R. S. F. S. R. - southeastern part, on Citellus pygmaeus (Zasukhin and Tiflov, 1933: 437 - 442), Erinaceus rumanicus and Hemiechinus auritus (Zasukhin, 1936: 155 - 164). Turkmen S. S. R. - (Pomerantzev, 1950: 114 - 115); Ashkhabad Province: Ashkhabad, on hedgehog (Olenev, 1928: 29 - 34); near Ashkhabad, in burrows of Rhombomys opimus, Hemiechinus albulus, Paraechinus hypomelos, on hedgehog and Rhombomys opimus (Pospelova-Shtrom, 1936: 97 - 104). Kirghiz S. S. R. - Frunze (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 114 - 115); Osch - (Pomerantzev, 1950: 114 - 115). Kazakh S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 114 - 115); Dzhambeity (Zasukhin, 1933: 31 - 46; Olenev, 1934: 367 - 388; Zasukhin, 1935: 1 - 159), on Hemiechinus auritus (Zasukhin, 1936: 219 - 226); Manguishlak Peninsula (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Ust-Urt (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159); Mailibash, east of Kazalinsk (Olenev, 1934: 367 - 388), on Putorius eversmanni (Olenev, 1928: 29 - 34); northwest part of Sir-Darinsky Region on Putorius eversmanni (Olenev, 1930: 604 - 610), near Tashkent, on cattle (Olenev, 1930: 604 - 610). Tadzhik S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 114 - 115), on Hemiechinus albulus (Pomerantzev, 1935: 115 - 134). Uzbek S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 114 - 115).

On following hosts without definite indication of locality:

hedgehog (Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), on cattle (Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 114 - 115), rodents (Olenev, 1931: 3 - 125), Hemiechinus auritus (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pospelova-Shtrom, 1936: 97 - 104), Putorius eversmanni (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pospelova-Shtrom, 1936: 97 - 104), Citellus pygmaeus (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pospelova-Shtrom, 1936: 97 - 104), Hemiechinus albulus, Paraechinus hypomelos, Vormela sarmatica, Rhombomys opimus, Spermophilopsis leptodactylus (Pospelova-Shtrom, 1936: 97 - 104), small mammals inhabiting holes or lairs (Pomerantzev, 1950: 114 - 115).

Biology

Hosts of stages: All stages were found mostly on small mammals living in lairs (Pospelova-Shtrom, 1936: 97 - 104).

Seasonal activity: The adults occurred from April to October but some were taken in November, December and January. Immature stages were collected from September - January but there were records in May - June for nymphs and in July for larvae (Pospelova-Shtrom, 1936: 97 - 104).

Habitats: All stages were adapted to life in closed biotopes such as caves and especially in the holes and burrows of their hosts (Pospelova-Shtrom, 1936: 97 - 104). They were found in the semi-desert region (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 13) and desert regions of Central Asia (Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 13) and in the southern part of the desert zone in the Southeastern Lower Volga Region and in Western Kazahh (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159).

Haemaphysalis japonica var. douglasi Nuttall and Warburton

Haemaphysalis japonica var. douglasi Nuttall and Warburton, 1915: 403; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Shpringgoltz-Shmidt, 1935: 137 - 186; Pospelova-Shtrom, 1935: 205 - 217; Pospelova-Shtrom, 1936: 97 - 104; Pospelova-Shtrom, 1939: 80; Moskvin, 1940: 12 - 13; Pomerantzev and Serdyukova, 1940: 336 - 337; Kozlova and Grachev, 1941: 17 - 19; Ryzhov and Kozlova, 1941: 34 - 40; Zhmaeva, 1941: 14; Pervomaisky, 1941: 81 - 94; Gruzdeva, 1943: 102 - 104; Nelzina, 1945: 55 - 60; Pomerantzev, 1946: 1 -

28; Pervomaisky, 1947: 75 - 78; Pavlovsky, 1947: 160 - 201; Pavlovsky, 1947: 265 - 285; Pomerantzev and Serdyukova, 1948: 47 - 67; Pomerantzev, 1950: 122 - 123.

Localities and Hosts

Asia

China - (Olenev, 1931: 126 - 139; Pomerantzev, 1950: 122 - 123); north part (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28). Japan - (Pomerantzev, 1950: 122 - 123). Korea - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 122 - 123).

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Russian Far East - (Pervomaisky, 1941: 81 - 94; Pavlovsky, 1947: 160 - 201; Pomerantzev and Serdyukova, 1948: 47 - 67). Primor Territory (Pospelova-Shtrom, 1935: 205 - 207; Zhmaeva, 1941: 14; Gruzdeva, 1943: 102 - 104; Shpringgoltz-Shmidt, 1935: 137 - 186; Pavlovsky, 1947: 265 - 285), on domestic animals and man (Nelzina, 1945: 55 - 60); near Vladivostok, on Cervus hortulorum (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139); southern part of territory (Pomerantzev, 1950: 122 - 123); Amur delta in Potschan Peninsula (Pospelova-Shtrom, 1935: 205 - 217); Chernigov District, Gorny Village, on horse (Pospelova-Shtrom, 1935: 205 - 217); south of Ussuri Province (Ryzhov and Kozlova, 1941: 34 - 40; Pospelova-Shtrom, 1936: 97 - 104), on birds (Moskvin, 1940: 12 - 13; Kozlova and Grachev, 1941: 17 - 19); Ussuri forests (Pomerantzev, 1946: 1 - 28); Suputin Forest Reserve (Pomerantzev and Serdyukova, 1940: 336 - 337; Pervomaisky, 1947: 75 - 78).

On following hosts without definite indication of locality: spotted deer, lynx, rabbit (Pospelova-Shtrom, 1936: 97 - 104), wild and domestic animals, small mammals (Pomerantzev, 1946: 1 - 28), birds, man (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 122 - 123), badger, hedgehog, cattle, dogs, rodents (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 122 - 123), deer, bear, hare (Pomerantzev, 1950: 122 - 123).

Biology

Hosts of stages: Adult - Cervus hortulorum (Olenev, 1931: 3 -

125; Olenev, 1931: 126 - 139), spotted deer (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 122 - 123), horse (Pospelova-Shtrom, 1935: 205 - 217), lynx (Pospelova-Shtrom, 1936: 97 - 104), badger, rabbit, hedgehog, cattle dogs (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 122 - 123), man (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 122 - 123), bear (Pomerantzev, 1950: 122 - 123), domestic animals (Nelzina, 1945: 55 - 60; Pomerantzev, 1946: 1 - 28), wild animals (Pomerantzev, 1946: 1 - 28).

Immature stages - spotted deer, dog, badger, small rodents (Pospelova-Shtrom , 1936: 97 - 104; Pomerantzev, 1950: 122 - 123), birds (Pospelova-Shtrom, 1936: 97 - 104; Moskvin, 1940: 12 - 13; Kozlova and Grachev, 1941: 17 - 19; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 122 - 123), small mammals (Pomerantzev, 1946: 1 - 28), man (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 122 - 123).

Seasonal activity: The adults showed a peak of activity in the spring-summer period and another in the fall-winter season (Nelzina, 1945: 55 - 60). Only males were found from November to March and were responsible for the second peak (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 122 - 123; Nelzina, 1945: 55 - 60). Females, however, predominated in the spring-summer period (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 122 - 123). The immature stages were active in the spring-summer season (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 122 - 123; Pervomaisky, 1947: 75 - 78).

Habitats: All stages were found in the timber zone (Olenev, 1931: 3 - 125) and in the Ussuri type forest (Pomerantzev, 1946: 1 - 28) being more abundant in undisturbed parts of the forest than in those adjoining settlements (Pervomaisky, 1941: 81 - 94).

Parasites: Specimens of Hunterellus hookeri were obtained from 3 nymphs (Pervomaisky, 1947: 75 - 78).

Relation to Disease

It was suspected of transmitting Far Eastern tick typhus (Pavlovsky, 1947: 265 - 285; Pomerantzev, 1950: 122 - 123) and spring-summer encephalitis (Pavlovsky, 1947: 160 - 201; Pomerantzev, 1950: 122 - 123).

Haemaphysalis pavlovskyi Pospelova-Shtrom

Haemaphysalis pavlovskyi Pospelova-Shtrom, 1935: 205 - 217; Pospelova-

Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 117 - 118.

Localities and Hosts

Tadzhik S. S. R. - near Togul, in vicinity of Sarai-kamara, on Phasianus chrysomelos bianchii (Pospelova-Shtrom, 1935: 205 - 217; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 117 - 118); Kzyl-Su, on rabbit (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 117 - 118).

Biology

Hosts of stages: Male - Phasianus chrysomelos bianchii (Pospelova-Shtrom, 1935: 205 - 217; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 117 - 118). Nymph - rabbit (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 117 - 118).

Seasonal activity: Males were collected in July (Pospelova-Shtrom, 1935: 205 - 217; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 117 - 118) and nymphs were taken in July, August and September (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 117 - 118).

Haemaphysalis punctata Can. and Fanz.

Haemaphysalis punctata Canestrini and Fanzago, 1877 - 1878: 189; Canestrini, 1890: 523, 525; Berlese, 1891: fasc. 58, in part; Neumann, 1897: 327, in part; Neumann, 1911: 107 - 108, in part; Yakimov, 1917: 298 - 301; Kotlán, 1919: 34 - 35; Kotlán, 1921: 43 - 50; Olenev, 1930: 604 - 610; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev and Kastrov, 1932: 28 - 30; Zasukhin, 1933: 31 - 46; Olenev, 1934: 672 - 674; Olenev, 1934: 367 - 388; Pospelova-Shtrom, 1935: 135 - 148; Pospelova-Shtrom, 1935: 247; Galuzo, et al., 1935: 167 - 185; Pospelova-Shtrom, 1935: 115 - 134; Zasukhin, 1935: 1 - 159; Pospelova-Shtrom, 1936: 97 - 104; Zasukhin, 1936: 457 - 460; Delpy, 1938: 1 - 10; Pospelova-Shtrom, 1939: 75; Pomerantzev and Matikashvili, 1940: 100 - 133; Pospelova-Shtrom, 1945: 12 - 18; Pomerantzev, 1946: 1 - 28; Pavlovsky, 1948: 581; Pomerantzev, 1950: 101 - 105; Shatas, 1952: 802 - 818;

Melnikova, 1953: 422 - 434.

Haemaphysalis cinnabarina punctata, Knuth, et al., 1918: 241 - 264; Zakharov, 1926: 53 - 59; Olenev, 1928: 84 - 96; Olenev, 1928: 29 - 34; Zasukhin and Tiflov, 1933: 437 - 442; Zolotarev, 1934: 217 - 227; Yakimov, et al., 1934: 235 - 254; Pavlovsky and Pomerantzev, 1934: 49 - 62; Mlinac and Oswald, 1936: 415 - 421; Delpy, 1938: 1 - 10; Kurchatov, 1940: 32; Kurchatov and Sokolov, 1940: 35; Tzelishcheva, 1941: 34 - 36; Korneev, 1941: 24; Pavlov and Miljowski, 1942: 539 - 542; Pavlov, 1942: 227 - 232; Galuzo, et al., 1944: 123 - 137; Cherkassky, 1945: 24 - 27; Grobov, 1946: 59 - 63; Pletzity, 1947: 877 - 878; Khayyat and Gilder, 1947: 119 - 126.

Haemaphysalis cinnabarina var. punctata, Nuttall and Warburton, 1915: 377 - 387, 519, 528, in part; Olenev, 1929: 309 - 314; Olenev, 1931: 3 - 125; Demidov, et al., 1944: 22.

Haemaphysalis crassa Warburton, 1908: 516 - 517.

Rhipicephalus expositicus Koch, 1877: 196.

Localities and Hosts

Europe

Europe - (Pospelova-Shtrom, 1936: 97 - 104); southern and central parts (Olenev, 1931: 126 - 139). Scandinavia - southern part (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105). Sweden - (Olenev, 1934: 367 - 388). Denmark - (Olenev, 1934: 367 - 388; Pomerantzev, 1950: 101 - 105; Nuttall and Warburton, 1915: 377 - 387). Germany - (Neumann, 1911: 107 - 108; Olenev, 1934: 367 - 388; Pomerantzev, 1950: 101 - 105; Nuttall and Warburton, 1915: 377 - 387). Rumania - (Neumann, 1911: 107 - 108). Bulgaria - Wratza district, on goats (Pavlov, 1942: 227 - 232). Croatia - (Neumann, 1911: 107 - 108; Nuttall and Warburton, 1915: 377 - 387). Dalmatia - (Neumann, 1911: 107 - 108; Nuttall and Warburton, 1915: 377 - 387). Jugoslavia - (Mlinac and Oswald, 1936: 415 - 421). Hungary - (Kotlán, 1919: 34 - 35; Pomerantzev, 1950: 101 - 105; Nuttall and Warburton, 1915: 377 - 387), on horses, dogs, cattle (Kotlán, 1921: 43 - 50). Mediterranean Region - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Nuttall and Warburton, 1915: 377 - 387; Pomerantzev, 1950: 101 - 105); Macedonia - horses (Knuth, et al., 1918: 241 - 264); Serbian Macedonia between Lake Ochrida and the Vardar, on sheep, goats, cattle, dogs (Pavlov and Miljowski, 1942: 539 - 542). Balkan Peninsuka - (Pomerantzev, 1950: 101 - 105). Greece - (Nuttall and

Warburton, 1915: 377 - 387).

Asia

Asia Minor - (Olenev, 1931: 126 - 139; Pomerantzev, 1950: 101 - 105). Turkey - (Pospelova-Shtrom, 1936: 97 - 104). Iran - (Pomerantzev, 1950: 101 - 105), on cattle, sheep (Delpy, 1938: 1 - 10). Iraq - on sheep (Khayyat and Gilder, 1947: 119 - 126). Japan - (Olenev, 1931: 126 - 139; Neumann, 1911: 107 - 108; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105).

U. S. S. R.

U. S. S. R. - (Yakimov, 1917: 298 - 301; Olenev, 1934: 367 - 380; Pomerantzev, 1950: 101 - 105).

R. S. F. S. R. - southeastern part, on Citellus pygmaeus (Zasukhin and Tiflov, 1933: 437 - 442); Voronezh Province, on cattle (Korneev, 1941: 24); Leningrad Province: Bolshoy Izhory, on cattle (Olenev, 1934: 672 - 674; Pospelova-Shtrom, 1936: 97 - 104); Stalingrad Province: Verkhne-Kurmoyarsky, Kotelnikovo, Gorodishchensky, on cattle, hedgehogs, partridge (Shatas, 1952: 802 - 818); Urupinsk (Zasukhin, 1935: 1 - 159; Shatas, 1952: 802 - 818); North Volga Region: Niznechrok and Bazarnokarabulak (Zasukhin, 1935: 1 - 159); Lower Volga Region: (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 101 - 105); Tschersky district (Zasukhin, 1933: 31 - 46).

Ukrainian S. S. R. - (Olenev, 1934: 367 - 388); southern part (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 101 - 105); Poltava Province (Olenev, 1928: 84 - 96), on Turdus viscivorus (Nuttall and Warburton, 1915: 377 - 387); Kherson Province: (Olenev, 1928: 84 - 96), Ananiewsk District (Nuttall and Warburton, 1915: 377 - 387). Moldavian S. S. R. - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 101 - 105; Olenev, 1928: 84 - 96); Izmail (Olenev, 1928: 29 - 34). Tadzhik S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104), on cattle, sheep (Pospelova-Shtrom, 1935: 135 - 148), Sturnus purpurascens abt. dresseri (Pospelova-Shtrom, 1935: 115 - 134); Gissar Valley (Galuzo, et al., 1935: 167 - 185; Pomerantzev, 1950: 101 - 105). Kazakh S. S. R. - (Olenev, 1934: 367 - 388 ; Pospelova-Shtrom, 1936: 97 - 104), on cattle (Tzelishcheva, 1941: 34 - 36); eastern and western parts (Pomerantzev, 1950: 101 - 105); western part in vicinity of Novaya Kazanka (Zasukhin, 1935: 1 - 159; Zasukhin, 1933: 31 - 46); Kzyl Orda Province, on horse, cattle, Phasianus colchicus turkestanicus (Olenev, 1930: 604 - 610); southern part, on cattle, sheep (Galuzo, et al.,

1944: 123 - 137).

Georgian S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104). Armenian S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104); central part (Pavlovsky and Pomerantzev, 1934: 49 - 62). Azerbaijan S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104), on zebu (Yakimov, et al., 1934: 235 - 254); Geokchay, on cattle (Olenev, 1928: 29 - 34); Lenkoran (Olenev, 1928: 29 - 34). Uzbek S. S. R. - (Pomerantzev, 1950: 101 - 105). Kirghiz S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105). Turkestan - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314).

Crimean A. S. S. R. - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 101 - 105; Kurchatov, 1940: 32; Kurchatov and Sokolov, 1940: 35); Kerch Peninsula (Grobov, 1946: 59 - 63); Alabatch - Chyr Alan districts and southern part of Gornoe-ozero (Melnikova, 1953: 422 - 434); Olsui; Bolgar; Sarabuza; Salgirka; vicinity of Neizats; Tshumakarka; Iaman-Koln near Baidar (Olenev, 1928: 29 - 34). Kalmuk A. S. S. R. - (Pomerantzev, 1946: 1 - 28). Daghestan, A. S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104), on cattle, horse, sheep, goats (Zolotarev, 1934: 217 - 227); Babaiurt, on cattle, horses; Buinak, on cattle (Olenev and Kastrov, 1932: 28 - 30). Abkhazskaya A. S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104); Sukhumi (Olenev, 1928: 29 - 34).

Stavropol Territory - Vorontsova-Alexandrovskoe, on cattle (Olenev and Kastrov, 1932: 28 - 30). Western Territory - Russukha, Unechski Region, on cattle (Olenev, 1934: 672 - 674; Pospelova-Shtrom, 1936: 97 - 104). Central Asiatic Republics - (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 101 - 105); Perovsk, on Phasianus colchicus turkestanicus (Olenev, 1928: 29 - 34). Caucasia - (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 101 - 105; Olenev, 1928: 84 - 96; Olenev, 1928: 29 - 34; Nuttall and Warburton, 1915: 377 - 387; Olenev, 1929: 305 - 314). North Caucasus (Pospelova-Shtrom, 1936: 97 - 104), on domestic animals, man (Zakharov, 1926: 53 - 59), horses (Demidov, et al., 1944: 22); Prikumsky district, on cattle (Olenev and Kastrov, 1932: 28 - 30); eastern part, Aksai, on cattle (Olenev and Kastrov, 1932: 28 - 30); Azov-Black Sea Area - (Pospelova-Shtrom, 1936: 97 - 104), mineral waters north of Lake Tambukon (Olenev, 1928: 29 - 34). Transcaucasia - central, eastern and southern parts (Pomerantzev and Matikashvili, 1940: 100 - 133); Black Sea Coast (Pospelova-Shtrom, 1936: 97 - 104); Zurnabad, on cattle (Olenev, 1928: 29 - 34).

On following hosts without definite indication of locality:

cattle, (Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Olenev, 1934: 367 - 388; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1928: 84 - 96), pheasant (Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104); Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105; Olenev, 1928: 84 - 96), Citellus pygmaeus (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105), sheep (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105; Olenev, 1928: 84 - 96), horses (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105; Olenev, 1928: 84 - 96), goats (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105; Olenev, 1928: 84 - 96), buffalo (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105), camel (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105), donkey (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105), deer (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105), pig (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105), turkey (Pospelova-Shtrom, 1936: 97 - 104), rook (Pospelova-Shtrom, 1936: 97 - 104), man (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 101 - 105), hedgehog (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105; Olenev, 1928: 84 - 96), rabbits (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105), chickens (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105), starling, Anthus campestris, larks (Pospelova-Shtrom, 1936: 97 - 104), reptiles (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105), Emberiza calandra, Galerida cristata caucasica (Pomerantzev and Matikashvili, 1940: 100 - 133), domestic animals (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 101 - 105; Melnikova, 1953: 422 - 434), birds (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 101 - 105), small mammals (Pomerantzev, 1946: 1 - 28), large mammals (Pomerantzev, 1950: 101 - 105), lizards, snakes (Olenev, 1928: 84 - 96).

Biology

Life history: Under laboratory conditions oviposition began 10 to 211 days after engorgement was completed and from 3000 to 5000 eggs were deposited. The larvae hatched in from 24 to 82 days after the eggs were laid. The larvae fed in 3 to 21 days and required 14 to 243

days before molting to the nymphal stage. Unfed larvae survived for 303 days. Nymphs completed engorgement in 4 to 229 days and molted to the adult stage in 7 to 229 days. Unfed nymphs lived for 252 days. The females required 6 to 30 days to complete feeding and some unfed females survived for 255 days (Pomerantzev, 1950: 101 - 105).

Hosts of stages: Adult - cattle (Shatas, 1952: 802 - 818; Olenev, 1930: 604 - 610; Olenev, 1931: 3 - 125; Olenev and Kastrov, 1932: 28 - 30; Zasukhin, 1933: 31 - 46; Kotlán, 1921: 43 - 50; Olenev, 1934: 672 - 674; Olenev, 1934: 367 - 388; Pospelova-Shtrom, 1935: 135 - 148; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Zolotarev, 1934: 217 - 227; Delpy, 1938: 1 - 10; Zakharov, 1926: 53 - 59; Kurchatov, 1940: 32), horses (Demidov, et al., 1944: 22; Kotlán, 1921: 43 - 50; Olenev and Kastrov, 1932: 28 - 30; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105; Knuth et al., 1918: 241 - 264; Zakharov, 1926: 53 - 59; Zolotarev, 1934: 217 - 227), dogs (Kotlán, 1921: 43 - 50), sheep (Pospelova-Shtrom, 1935: 135 - 148; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105; Zakharov, 1926: 53 - 59; Zolotarev, 1934: 217 - 227; Delpy, 1938: 1 - 10), goats (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105; Zolotarev, 1934: 217 - 227), buffalo (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105), camel, donkey, deer, pig (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105), turkey (Pospelova-Shtrom, 1936: 97 - 104), pheasant (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105), rook (Pospelova-Shtrom, 1936: 97 - 104), man (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 101 - 105), hares (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105), domestic animals (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 101 - 105; Melnikova, 1953: 422 - 434), birds (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 101 - 105), zebu (Yakimov, et al., 1934: 235 - 254).

Nymph - cattle (Shatas, 1952: 802 - 818), horse (Knuth, et al., 1918: 241 - 264), hedgehogs (Shatas, 1952: 802 - 818), Turdus viscivorus (Nuttall and Warburton, 1915: 377 - 387), starling (Pospelova-Shtrom, 1935: 135 - 148), Sturnus purpurascens abt. dresseri (Pospelova-Shtrom, 1935: 115 - 134).

Larva - hedgehogs and birds (Shatas, 1952: 802 - 818).

Immature stages - hedgehogs (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 101 - 105), rabbits (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev,

1950: 101 - 105), Citellus pygmaeus (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105), cattle, sheep, horses (Pospelova-Shtrom, 1936: 97 - 104), birds (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 101 - 105; Kurchatov, 1940: 32), chickens (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105), pheasant (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105), rooks, starling, Anthus campestris, larks (Pospelova-Shtrom, 1936: 97 - 104), reptiles (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105; Kurchatov, 1940: 32), Emberiza calandra, Galerida cristata caucasica (Pomerantzev and Matikashvili, 1940: 100 - 133), small mammals (Pomerantzev, 1946: 1 - 28; Kurchatov, 1940: 32).

Seasonal activity: In the U. S. S. R. the adults were active in spring and autumn and showed maximum abundance in March - April and September - October (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105). In regions with colder climate the autumn parasitization began earlier and the spring parasitization extended into mid-summer (Pospelova-Shtrom, 1936: 97 - 104). In the more southern parts the adults occurred in the winter as well as the rest of the year (Pomerantzev, 1950: 101 - 105). In Crimea they occurred from March to December with one peak of abundance in April - May and another in September - November (Melnikova, 1953: 422 - 434). In Transcaucasia the adults were present all year and were abundant in the autumn-winter-spring period and though they were occasionally found in the summer they were present only in insignificant numbers. A certain depression of activity occurred also in the mid-winter period (Pomerantzev and Matikashvili, 1940: 100 - 133). In western Kazakhstan and in the Lower Volga Regions the adults were found from July to October (Zasukhin, 1935: 1 - 159). In Stalingrad Province, the adults were collected from April to September (Shatas, 1952: 802 - 818). In the U. S. S. R. the larvae and nymphs occurred in the spring but the greatest numbers were found in summer (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 101 - 105). The larvae appeared first followed by the nymphs (Pospelova-Shtrom, 1936: 97 - 104). In Crimea larvae and nymphs were active in May, June and August (Melnikova, 1953: 422 - 434) and in Transcaucasia they were found in June and July (Pomerantzev and Matikashvili, 1940: 100 - 133). In Stalingrad Province the nymphs and larvae were found in April and May (Shatas, 1952: 802 - 818).

Habitats: All stages were found in the mountain zone (Pospelova-Shtrom, 1936: 97 - 104; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 101 - 104; Melnikova, 1953: 422 - 434), in the steppe zone (Pospelova-Shtrom, 1936: 97 - 104; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 101 -

105; Zasukhin, 1935: 1 - 159; Zasukhin, 1933: 31 - 46), in the desert zone (Pospelova-Shtrom, 1936: 97 - 104; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 101 - 105), in the mountain steppes (Olenev, 1931: 3 - 125; Pomerantzev, 1950: 101 - 105; Pomerantzev and Matikashvili, 1940: 100 - 133), in the semi-desert zone (Pomerantzev and Matikashvili, 1940: 100 - 133; Zasukhin, 1935: 1 - 159; Zasukhin, 1933: 31 - 46), in the semi-steppe zone and in the forest zone (Pomerantzev and Matikashvili, 1940: 100 - 133). They also were found along the more humid river valleys and lakes (Pospelova-Shtrom, 1936: 97 - 104; Shatas, 1952: 802 - 818) but not in areas where extreme moisture occurred (Pospelova-Shtrom, 1936: 97 - 104).

Control Measures

Effective control was obtained by spraying cattle with a dilute paste of pyrethrum and with pyrethrum powder at the rate of about 85 grams per cow, but reinfestation began on the 6th day after application when a heavy rain washed off the dust (Cherkassky, 1945: 24 - 27).

Relation to Disease

Piroplasmosis: H. punctata transmitted Babesia bigemina and Theileria mutans to cattle (Pomerantzev, 1950: 101 - 105; Tzelishcheva, 1941: 34 - 36; Korneev, 1941: 24).

Brucellosis: Though Brucella abortus was inaccessible to ticks owing to its position in the body of cattle, B. melitensis was capable of being ingested by ticks that fed on infected sheep. These infected ticks transmitted the infection to other animals through the bites of subsequent stages (Galuzo, et al., 1944: 123 - 137) and H. punctata was regarded as a possible vector (Pomerantzev, 1950: 101 - 105).

Tularemia: Though this species did not experimentally transmit Bacterium tularense transovarially (Zasukhin, 1936: 457 - 460), it was regarded as a carrier in Stalingrad Province (Shatas, 1952: 802 - 818).

Tick-borne Typhus: Strains of rickettsiae similar to those of tick-borne typhus were isolated from H. punctata (Pletzity, 1947: 877 - 878) and it was regarded as a possible vector (Pomerantzev, 1950: 101 - 105).

Tick Paralysis: It was suspected of causing paralysis of sheep and man in the U. S. S. R. (Pomerantzev, 1950: 101 - 105). H. punctata

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was known to produce paralysis in sheep, goats and calves in Serbian Macedonia (Pavlov and Miljowski, 1942: 539 - 542) and in goats in Bulgaria (Pavlov, 1942: 227 - 232).

Haemaphysalis sulcata (Can. and Fanz.)

Herpetobia sulcata Canestrini and Fanzago, 1877/1878: 188; Canestrini, 1890: 527.

Haemaphysalis sulcata, Neumann, 1911: 117; Pavlovsky and Pomerantzev, 1934: 49 - 62; Zolotarev, 1934: 217 - 227; Pospelova-Shtrom, 1936: 97 - 104; Pospelova-Shtrom, 1939: 78; Pomerantzev and Matikashvili, 1940: 100 - 133; Kurchatov, 1940: 74 - 75; Pospelova-Shtrom, 1945: 12 - 18; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 105 - 108.

Haemaphysalis cholodkovskii Olenev, 1928: 29 - 34; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1929: 489 - 494; Olenev, 1931: 126 - 139; Olenev, 1931: 281 - 284; Olenev, 1931: 3 - 125; Olenev, 1934: 367 - 388; Pomerantzev, 1934: 63 - 66; Pavlovsky and Pomerantzev, 1934: 49 - 62; Zolotarev, 1934: 217 - 227; Pospelova-Shtrom, 1935: 135 - 148; Pospelova-Shtrom, 1935: 115 - 134: Delpy, 1938: 1 - 10.

Haemaphysalis punctata, Berlese, 1889, Fasc. LV; Berlese, 1891, Fasc. LVII; Neumann, 1897: 327, in part.

Haemaphysalis cinnabarina v. punctata, Nuttall and Warburton, 1915: 378, in part.

Haemaphysalis cinnabarina punctata f. musimonis Tonelli-Rondelli, 1930: 116.

Haemaphysalis nicollei Larrouse, 1925: 97.

Haemaphysalis montana Kamensky, 1928.

Haemaphysalis sewelli Sharif, 1928: 243.

Haemaphysalis cinnabarina v. cretica Senevet and Caminopetros, 1936: 24; Delpy, 1938: 1 - 10.

Not Haemaphysalis sulcata, Olenev, 1928: 29 - 34; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139.

Not Haemaphysalis sulcata otophila, Schulze, 1927: 113.

Localities and Hosts

Europe

Italy - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108), on Lacerta viridis and Lacerta muralis (Neumann, 1911: 117). Sardinia - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108). Sicily - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108). Corsica - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108). Balkan Peninsula - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108). Canary Islands - (Pospelova-Shtrom, 1936: 97 - 104). Mediterranean Area - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 105 - 108). Paros Island - (Pospelova-Shtrom, 1936: 97 - 104). Crete - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108).

Asia

Palestine - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 105 - 108), on Ophiops elegans (Pospelova-Shtrom, 1936: 97 - 104). India - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 105 - 108). Tibet - eastern part (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 105 - 108). Iran - (Pomerantzev, 1950: 105 - 108), on cattle, sheep, goats, gazelles (Delpy, 1938: 1 - 10); eastern and northeastern parts, on reptiles (Pospelova-Shtrom, 1936: 97 - 104).

U. S. S. R.

Armenian S. S. R. - (Pavlovsky and Pomerantzev, 1934: 49 - 62; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108); southwestern part in Valley of Arax (Pomerantzev, 1943: 63 - 66). Georgian S. S. R. - central and eastern parts (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108). Azerbaijan S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108). Kazakh S. S. R. - on sheep (Olenev, 1934: 367 - 388). Uzbek S. S. R. - Bukhara (Olenev, 1931: 3 - 125). Tadzhik S. S. R. - on cattle, sheep, goats (Pospelova-Shtrom, 1935: 135 - 148), on Hemiechinus albulus, Rattus turkestanicus, Testudo horsfieldi, Gymnodactylus fedtschenkoi, Agama aralensis (Pospelova-Shtrom, 1935: 115 - 134). Crimean A. S. S. R. - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104; Kurchatov, 1940: 32). Caucasia - (Olenev, 1931: 3 - 125; Olenev,

1931: 126 - 139; Pomerantzev, 1946: 1 - 28); northern part (Pospelova-Shtrom, 1936: 97 - 104). Ciscaucasia - (Pomerantzev, 1950: 105 - 108). Transcaucasia - (Olenev, 1928: 84 - 96); eastern, southern and western parts (Pomerantzev and Matikashvili, 1940: 100 - 133); eastern and southern parts (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 105 - 108). Central Asiatic Republics - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 105 - 108; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125). Turkestan - (Olenev, 1928: 84 - 96). Daghestan A. S. S. R. - (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 105 - 108), on camels, goats, dogs, sheep (Zolotarev, 1934: 217 - 227).

On following hosts without definite indication of locality: goats (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 105 - 108; Olenev, 1928: 29 - 34; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), sheep (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 105 - 108), cattle (Pospelova-Shtrom, 1936: 95 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133), horses (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 105 - 108), buffalo (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 105 - 108), cat (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108), Ovis musimon, Ovis orientalis cycloceros, Dama vulgaris, Testudo horsfieldi (Pospelova-Shtrom, 1936: 97 - 104), Testudo species (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133), snakes (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133), grass snakes, runner, Stellio caucasica, Stellio microlepis, Agama aralensis, Agama lehmanni (Pospelova-Shtrom, 1936: 97 - 104), Agama species (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108), Eumeces pavimentactus (Pospelova-Shtrom, 1936: 97 - 104), Eumeces schneideri (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133), Scyncyan lizard, Albephorus deserti, Eremias parduloides, Eremias velox, Eremias arguta, Eremias variabilis, Eremias regeli, Lacerta taurica, Lacerta viridis, Lacerta agilis, Lacerta depressa, Gymnodactylus fedtschenkoi, Ophiosaurus apus, Ophiosaurus elegans, sparrow, lark, ground birds, Lepus tolai, Hemiechinus albulus, Rattus turkestanicus, gophers (Pospelova-Shtrom, 1936: 97 - 104), birds (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108), lizards (Pomerantzev and Matikashvili, 1940: 100 - 133), turtles, Phrynocephalus helioscopus horvathi, Eremias stravehi, Eremias pleskei, Contia punctatolineata, Coluber ravergieri, Coronella austriaca, Oenanthe species, Galerida cristata caucasica, Anthus campestris campestris, Sitta neumayer neumayer, Emberiza melano-

cephala, Upupa epops, Cricetulus migratorius (Pomerantzev and Matikashvili, 1940: 100 - 133), hedgehogs, hares, rats, deer, European and Asiatic mouflons (Pomerantzev, 1950: 105 - 108).

Biology

Hosts of stages: Adult - goats (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 105 - 108; Olenev, 1928: 29 - 34; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), sheep (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 105 - 108; Olenev, 1934: 367 - 388), cattle (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133); horses (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 105 - 108), buffalo (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 105 - 108), cat (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108), Ovis musimon, Ovis orientalis cyclo-ceros, Dama vulgaris (Pospelova-Shtrom, 1936: 97 - 104), deer, European and Asiatic mouflons (Pomerantzev, 1950: 105 - 108).

Immature stages - Testudo horsfieldi (Pospelova-Shtrom, 1936: 97 - 104), Testudo species (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133), viper (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133), grass snake (Pospelova-Shtrom, 1936: 97 - 104), runner (Pospelova-Shtrom, 1936: 97 - 104), Stellio caucasica, Stellio microlepis, Agama aralensis, Agama lehmanni, Eumeces pavimentactus, Scyncyan lizard, Albephorus deserti, Eremias velox, Eremias arguta, Eremias variabilis, Eremias regeli, Lacerta taurica, Lacerta viridis, Lacerta agilis, Lacerta depressa, Gymnodactylus fedtschenkoi, Ophiosaurus apus, Ophiosaurus apus, Ophiosaurus elegans, sparrow, lark, ground birds (Pospelova-Shtrom, 1936: 97 - 104), Agama species (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108), Eumeces schneideri (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133), cattle (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133), sheep (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 105 - 108), goats (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 105 - 108), rabbits (Pospelova-Shtrom, 1936: 97 - 104), Lepus tolai (Pospelova-Shtrom, 1936: 97 - 104), Hemiechinus albulus (Pospelova-Shtrom, 1936: 97 - 104), Rattus turkestanicus (Pospelova-Shtrom, 1936: 97 - 104; Pospelova-Shtrom,

1935: 115 - 134), gophers (Pospelova-Shtrom, 1936: 97 - 104), lizards (Pomerantzev and Matikashvili, 1940: 100 - 133), turtles, Phrynocephalus helioscopus horvathi, Eremias stravehi, Eremias pleskei, Contia punctatolineata, Coluber ravergieri, Coronella austriaca, Oenanthe species, Galerida cristata caucasica, Anthus campestris campestris, Sitta neumayer neumayer, Emberiza melanocephala, Upupa epops, Cricetulus migratorius (Pomerantzev and Matikashvili, 1940: 100 - 133), Lacerta species, hedgehogs, hares, rats, birds and reptiles (Pomerantzev, 1950: 105 - 108), Agama aralensis (Pospelova-Shtrom, 1935: 115 - 134).

Larva - Testudo horsfieldi, Gymnodactylus fedtschenkoi, Hemiechinus albulus (Pospelova-Shtrom, 1935: 115 - 134), Ophiops elegans (Pospelova-Shtrom, 1936: 97 - 104).

Seasonal activity: The adults were active from September - November and from March - May; however, they were found throughout the winter in Central Asia. The immature stages were found from April to September and showed a peak of activity in May - June (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1950: 105 - 108).

In Transcaucasia the adults showed peaks of activity in the spring and in the autumn but they were present in reduced numbers in summer and winter. Larvae were found on lizards from the beginning of June to September and reached their maximum numbers toward the end of July. The nymphs appeared toward the end of July and remained active up to the last ten days of September. Maximum numbers of nymphs occurred from the second 10 days of July to the second 10 days of August (Pomerantzev and Matikashvili, 1940: 100 - 133).

Habitats: All stages were found in the desert zone (Pospelova-Shtrom, 1936: 97 - 104), in the semi-desert zone (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133), mountain steppe zone (Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133), in the semi-steppe zone (Pomerantzev and Matikashvili, 1940: 100 - 133), in the forest zone (Pomerantzev and Matikashvili, 1940: 100 - 133), in the steppe zone (Pospelova-Shtrom, 1936: 97 - 104; Kurchatov, 1940: 32) and in the forest steppe zone (Kurchatov, 1940: 32). They were not found in places having a wet climate, such as western Caucasia (Pospelova-Shtrom, 1936: 97 - 104).

Relation to Disease

This species caused tick paralysis and transmitted brucellosis to domestic animals (Pomerantzev, 1950: 105 - 108).

Haemaphysalis warburtoni Nuttall

Haemaphysalis warburtoni Nuttall, 1912: 55 - 57; Nuttall and Warburton, 1915: 369 - 372; Olenev, 1928: 29 - 34; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev, 1934: 367 - 388; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev and Matikashvili, 1940: 100 - 133; Karpov and Popov, 1944: 75 - 79; Pospelova-Shtrom, 1945: 12 - 18; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 97 - 101.

Localities and Hosts

Asia

China - Wen-chwan-hsien, near Si-ho-hsien, on Serow goat (Nuttall, 1912: 55 - 57; Nuttall and Warburton, 1915: 369 - 372; Olenev, 1928: 29 - 34; Olenev, 1931: 126 - 139; Pospelova-Shtrom, 1936: 97 - 104; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 97 - 101). Formosa - Taihoku, on cattle (Nuttall and Warburton, 1915: 369 - 372; Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1936: 97 - 104).

U. S. S. R.

Azerbaijan S. S. R. - (Pomerantzev, 1950: 97 - 101). Georgian S. S. R. - Akalkalakski, on cattle (Pospelova-Shtrom, 1936: 97 - 104), Akalkalakski district (Pomerantzev, 1950: 97 - 101). Kirghiz S. S. R. - northern part, near Issyk-Kul (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 97 - 101). Transcaucasia - Akalkalakski Mountains, on domestic animals (Pomerantzev and Matikashvili, 1940: 100 - 133), in Akalkalakski Region (Pomerantzev, 1946: 1 - 28). Western Siberia - Tscholesmantal, Altai Mountains (Nuttall and Warburton, 1915: 369 - 372; Olenev, 1928: 29 - 34; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev, 1934: 367 - 388; Pospelova-Shtrom, 1936: 97 - 104; Karpov and Popov, 1944: 75 - 79; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 97 - 101). R. S. F. S. R. - Novosibirsk Province - (Karpov and Popov, 1944: 75 - 79).

On following hosts without definite indication of locality: goats, cattle (Pomerantzev, 1946: 1 - 28), large, horned domestic animals, Alticola species (Pomerantzev, 1950: 97 - 101).

Biology

Life history: H. warburtoni required over one year to complete its cycle (Pomerantzev, 1950: 97 - 101).

Hosts of stages: Adult - on large, horned domestic animals; larva - on Alticola species (Pomerantzev, 1950: 97 - 101).

Seasonal activity: Adults were found in April, July, and September and the larvae were found in September (Pomerantzev, 1950: 97 - 101).

Habitats: This species was found in mountainous prairie (Pospelova-Shtrom, 1936: 97 - 104).

Hyalomma aegyptium (Linné)

Delpy, in several works, stated that Hyalomma aegyptium occurred on terrestrial tortoises and snakes and that records of this species off mammals were other species of Hyalomma. Undoubtedly this species showed a host preference for reptiles but it occasionally occurred on mammals, for in a collection of 3 males from Afghanistan two were found on Testudo horsfieldi and one was found on sheep. Possibly, earlier records of this species reported on domestic animals in the U. S. S. R. and in the neighboring countries were either Hyalomma savignyi or some other species of Hyalomma. For this reason these earlier doubtful records have not been included in this work.

Acarus aegyptius Linné, 1758: 615.

Hyalomma aegyptium, Schulze, 1930: 28 - 30; Olenev, 1930: 604 - 610; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Olenev, 1931: 249 - 261; Pospelova-Shtrom, 1935: 115 - 134; Delpy, 1936: 206 - 245; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 23, 26; Delpy, 1949: 464 - 494; Pomerantzev, 1950: 193 - 195.

Hyalomma syriacum Koch, 1844: 222; Neumann, 1911: 52; Yakimov, 1917: 298 - 301; Olenev, 1928: 29 - 34; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1930: 604 - 610; Olenev, 1931: 3 - 125; Olenev, 1931: 1931: 249 - 261; Delpy, 1936: 206 - 245; Delpy, 1949: 464 - 494.

Hyalomma affine Neumann, 1899: 291.

Dermacentor rosmari Ass, 1935: 601 - 697; Pomerantzev, 1950: 193.

Localities and Hosts

Europe

Europe - (Pomerantzev, 1946: 23, 26), Greece - (Pomerantzev, 1950: 193 - 195); Athens (Neumann, 1911: 52). Rumania - (Neumann, 1911: 52).

Asia

Baluchistan - (Pomerantzev, 1946: 23, 26; Pomerantzev, 1950: 193 - 195). Palestine - (Pomerantzev, 1946: 23, 26; Pomerantzev, 1950: 193 - 195). Afghanistan - (Pomerantzev, 1946: 23, 26; Pomerantzev, 1950: 193 - 195). Asia Minor - (Pomerantzev, 1946: 23, 26; Pomerantzev, 1950: 193 - 195; Neumann, 1911: 52; Olenev, 1931: 126 - 139). Syria - (Neumann, 1911: 52). Turkey - Penderekli, on Testudo species; Filios (Olenev, 1931: 249 - 361). Iran - Sarkhun, on Testudo species; Gasan-beliu; Post Bartos; Muan; Geidar-abad; Teheran (Olenev, 1931: 249 - 261).

U. S. S. R.

Russian - southern part (Neumann, 1911: 52). Caspian Sea Region - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314); western and eastern shores (Olenev, 1931: 3 - 125). Caucasia - (Olenev, 1931: 126 - 139; Pomerantzev, 1946: 23, 26); Black Sea Shore of Caucasus (Olenev, 1931: 3 - 125; Pomerantzev, 1950: 193 - 195; Olenev, 1928: 29 - 34; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314); eastern part (Olenev, 1931: 3 - 125). Transcaucasia - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314); central, eastern and southern parts, on Testudo species and hedgehogs (Pomerantzev and Matikashvili, 1940: 100 - 133). Turkestan - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314), on camels (Yakimov, 1917: 298 - 301).

Kazakh S. S. R. - southwestern part along the Caspian Sea on Testudo horsfieldi (Olenev, 1930: 604 - 610); Guriev Province: Mangyschlak, on Testudo horsfieldi (Olenev, 1928: 29 - 34). Tadzhik, S. S. R. - (Pomerantzev, 1946: 23, 26; Pomerantzev, 1950: 193 - 195), on Testudo horsfieldi (Pospelova-Shtrom, 1935: 115 - 134). Uzbek S. S. R.- (Pomerantzev, 1946: 23, 26; Pomerantzev, 1950: 193 - 195); Fergana Province: Fergana, on Testudo horsfieldi; Kolpar-Rovata (Olenev, 1928: 29 - 34); Bukhara Province (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314); Guzar (Olenev, 1928: 29 - 34). Georgian S. S. R. - (Pomerantzev, 1950: 193 - 195); Tibilisi (Olenev, 1931: 249 - 261; Olenev, 1928:

29 - 34). Turkmen S. S. R. - (Pomerantzev, 1950: 193 - 195); Balkhan Mountains (Olenev, 1931: 249 - 261); Geok-tepe (Olenev, 1928: 29 - 34). Armenian S. S. R. - (Pomerantzev, 1950: 193 - 195). Azerbaijan S. S. R. - (Pomerantzev, 1950: 193 - 195); Akstafa, on Testudo horsfieldi; Ashur-Ade, on Testudo horsfieldi; Lenkoran, on Testudo horsfieldi; Ak-Zyvar, on Testudo horsfieldi; Alyaty, on Testudo horsfieldi (Olenev, 1928: 29 - 34). Crimean A. S. S. R. - (Pomerantzev, 1950: 193 - 195). Krasnodar Territory - Novorossiysk, on Testudo ibera; Gelendzhik, on Testudo ibera (Olenev, 1928: 29 - 34).

On following hosts without definite indication of locality: Testudo species (Olenev, 1931: 3 - 125; Pomerantzev, 1946: 23, 26; Pomerantzev, 1950: 193 - 195; Olenev, 1928: 84 - 96), lizards (Olenev, 1928: 84 - 96; Neumann, 1911: 52), donkey (Olenev, 1931: 3 - 125; Pomerantzev, 1950: 193 - 195), dog (Olenev, 1931: 3 - 125; Pomerantzev, 1950: 193 - 195), hedgehogs (Pomerantzev, 1946: 23, 26), hamster (Pomerantzev, 1950: 193 - 195; Olenev, 1928: 84 - 96), other mammals (Pomerantzev, 1946: 23, 26).

Biology

Life history: H. aegyptium was reported to be a 3 host tick (Pomerantzev, 1950: 193 - 195).

Habitats: All stages were found in the semi-desert areas near mountains and in mountainous areas (Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1935: 115 - 134) and in all places where tortoises of the genus Testudo occur (Pomerantzev and Matikashvili, 1940: 100 - 133).

Seasonal activity: In Tadzhik adults were collected in the spring which was their active period but one individual was found in July in the Kara-tau Mountains; spring collections consisted of males exclusively while summer ones were of larvae and nymphs (Pospelova-Shtrom, 1931: 115 - 134).

Hyalomma detritum Schulze

Hyalomma detritum Schulze, 1919: 189 - 196; Pavlovsky, 1928: 1 - 104; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Yakimov, 1934: 235 - 254; Zasukhin, 1935: 1 - 159; Galuzo, et al., 1935: 167 - 185; Lavrentiev, 1938: 36 - 47; Tzelishcheva, 1940: 31 - 35; Pomerantzev and Matikashvili, 1940: 100 - 133; Vlasov, 1940: 134 - 142; Ga-

luzo, 1941: 51 - 55; Pavlovsky, et al., 1941: 48 - 50; Tzelishcheva, 1941: 63 - 164; Kurchatov, 1941: 97 - 103; Galuzo, 1943: 97 - 105; Galuzo, 1943: 41 - 47; Galuzo, 1944: 92 - 109; Pavlovsky, 1945: 65 - 92; Pomerantzev, 1946: 1 - 28; Lototzky and Pokrovsky, 1946: 64 - 74; Vorobeva and Pokrovsky, 1946: 90 - 91; Tzelishcheva, 1947: 20; Markov, et al., 1948: 13; Pavlovsky and Bernadskaya, 1948: 25 - 40; Pomerantzev, 1950: 206 - 209; Gajdusek, 1953: 1 - 140.

Hyalomma detritum perstrigatum Schulze, 1930: 22 - 48; Hoeppli and Feng, 1933: 29 - 43; Olenev, 1934: 367 - 388.

Hyalomma detritum rubrum Schulze and Olenev, in Schulze, 1930: 22 - 48; Olenev, 1930: 604 - 610; Olenev, 1931: 126 - 139; Olenev, 1931: 249 - 261; Olenev, 1931: 3 - 125; Olenev, 1934: 367 - 388; Yakimov, et al., 1934: 235 - 254; Pomerantzev, 1934: 63 - 66; Galuzo, 1935: 187 - 197.

Hyalomma mauritanicum, Pomerantzev and Matikashvili, 1940: 100 - 133.

Hyalomma scupense Schulze, 1918: 62; Knuth, et al., 1918: 241 - 264; Schulze and Schlottke, 1929: 34 - 46; Olenev, 1934: 367 - 388; Oswald, 1937: 265 - 273; Pomerantzev and Matikashvili, 1940: 100 - 133; Markov, et al., 1940: 122 - 125; Nikolsky, 1940: 9 - 15; Serdyukova, 1946: 60 - 63; Pomerantzev, 1946: 1 - 28; Markov, et al., 1948: 13; Petunin, 1948: 14; Nikolsky, 1948: 29 - 33; Pomerantzev, 1950: 209 - 211; Alfeev, 1951: 398 - 403; Shatas, 1952: 802 - 818; Melnikova, 1953: 422 - 434.

Hyalomma uralense Schulze and Schlottke, 1929: 38, 43, 7, 12; Schulze, 1930: 47; Olenev, 1930: 604 - 610; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev, 1931: 249 - 261; Zasukhin, 1931: 275 - 282; Zasukhin, 1932: 181 - 185; Kolpakova and Lippert, 1932: 191 - 195; Zasukhin, 1933: 31 - 46; Olenev, 1934: 367 - 388; Zasukhin, 1935: 1 - 159; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28.

Hyalomma verae Olenev, 1931: 249 - 261; Olenev, 1934: 367 - 388; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 209.

Hyalomma detritum albipictum Schulze, 1919: 189 - 196; Yamashita, 1939: 602 - 609.

Hyalomma volgense Schulze and Schlottke, 1929: 35; Schulze, 1930: 44; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev, 1931: 249 - 261; Olenev and Kastrov, 1932: 28 - 30; Borzenkov and Donskov, 1933: 25 - 30; Olenev, 1934: 367 - 388; Kurchatov and Kalmikov, 1934: 80 pp.; Zolotarev, 1934: 217 - 227; Zasukhin, 1935: 1 - 159; Galuzo, 1935: 187 - 197; Kochetkov, 1935: 124 - 127; Pogorely, 1936: 533 - 537; Pomerantzev and Matikashvili, 1940: 100 - 133; Kurchatov, 1940: 32; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 209.

Localities and Hosts

Europe

Jugoslavia - (Oswald, 1937: 265 - 273; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 209 - 211); Uskiub (Olenev, 1934: 367 - 388). Macedonia - (Schulze, 1919: 189 - 196; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209), on horse (Knuth, et al., 1918: 241 - 264).

Asia

China - (Pomerantzev, 1946: 1 - 28), on cattle (Hoeppli and Feng, 1933: 29 - 43); Peking (Schulze, 1919: 189 - 196; Pomerantzev, 1950: 206 - 209; Olenev, 1934: 367 - 388); Tsingtau (Pomerantzev, 1950: 206 - 209); Chihli Province (Schulze, 1930: 22 - 48); near Lake Sogo-Nor (Pomerantzev, 1946: 1 - 28; Olenev, 1934: 367 - 388), on Gazella subgutturosa (Olenev, 1931: 249 - 261). Iran - (Pomerantzev, 1946: 1 - 28); Mendzel; Gilian; Semnan; Sebzevar (Pomerantzev, 1950: 206 - 209).

U. S. S. R.

Armenian S. S. R. - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209), on cattle (Galuzo, 1935: 187 - 197); southwestern part (Pomerantzev, 1934: 63 - 66).

Azerbaijan S. S. R. - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209), on domestic animals (Kurchatov, 1941: 97 - 103), zebu (Yakimov, et al., 1934: 235 - 254).

Georgian S. S. R. - (Pomerantzev and Matikashvili, 1940: 100 - 133); eastern part (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209).

Kazakh S. S. R. - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125), on domestic animals (Galuzo, 1941: 51 - 55), Sus scrofa (Schulze, 1930: 22 - 48); southern part (Galuzo, et al., 1935: 167 - 185), on cattle (Tzelishcheva, 1940: 31 - 35; Tzelishcheva, 1941: 63 - 64; Galuzo, 1944: 92 - 109), horse (Zasukhin, 1932: 181 - 185); southeastern part, on cattle (Tzelishcheva, 1947: 20; Olenev, 1930: 604 - 610), camel, horse, sheep, goat, donkey, boar (Olenev, 1930: 604 - 610); northern part, on horse (Zasukhin, 1932: 181 - 185); northeastern part, on cattle (Tzelishcheva, 1947: 20); northwestern part (Olenev, 1930: 604 - 610), on man, camel, horse, cattle (Olenev, 1931: 3 - 125);

western part, on camel (Kolpakova and Lippert, 1932: 192 - 195), cattle (Zasukhin, 1931: 275 - 282); Aral-Tyube, on horse (Olenev, 1931: 249 - 261); Aktyubinsk Province: (Zasukhin, 1933: 31 - 46), Irgiz, Toman, Shet Irgiz, on horse (Olenev, 1931: 249 - 261); Kzyl-Orda Province: Aral'sk (Olenev, 1934: 367 - 388), on camel, horse (Olenev, 1931: 249 - 261); Kazalinsk (Olenev, 1934: 367 - 388); Karmaktschi, on camel (Olenev, 1931: 249 - 261); Kzyl-Orda, on camel, horse, cattle; Ala-Mesek, on horse, sheep, goat (Olenev, 1931: 249 - 261); Golodnaya Steppe, on horse, Solo-Tyube on boar; Teren-Uzyak, on camel, horse, cattle; Chiili, on camel, horse, cattle, sheep, donkey (Olenev, 1931: 249 - 261); Kustanay Province: Turgai (Olenev, 1931: 249 - 261); Chimkent Province: Arys, on camel, horse, cattle; Saryagach, Chimkent, on camel, horse, cattle (Olenev, 1931: 249 - 261); Alma Ata Province: Dzarkent, on cattle; Aulie-Ata (Olenev, 1931: 249 - 261); Dzhambul Province: Novotroitskoye (Olenev, 1934: 367 - 388), on cattle, camel (Olenev, 1931: 249 - 261); Zapadno-Kazakh Province: Ural'sk (Olenev, 1931: 3 - 125; Olenev, 1934: 367 - 388; Olenev, 1931: 126 - 139; Olenev, 1931: 249 - 261; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159); Kalmykov, Novaya Kazanka; Urda, Uschtagon; Dzhambeity; Slomikhin (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159); Guryev Province: Guryev (Zasukhin, 1933: 31 - 46; Olenev, 1934: 367 - 388; Zasukhin, 1935: 1 - 159).

R. S. F. S. R. - Astrakhan Province: northern districts (Shatas, 1952: 802 - 818); Astrakhan; Kharabali (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159); Grozny Province: Chernyy Rynok, on cattle; Aksai, on cattle; Tolovka, on cattle (Olenev and Kastrov, 1932: 28 - 30); Kursk Province: (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 209 - 211; Olenev, 1931: 126 - 139; Olenev, 1934: 367 - 388), on cattle (Olenev, 1931: 3 - 125; Olenev, 1931: 249 - 261); Saratov Province: (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 209 - 211; Olenev, 1934: 367 - 388), on cattle (Zasukhin, 1935: 1 - 159; Olenev, 1931: 3 - 125; Olenev, 1931: 249 - 261); Novouzensk, Ozink; Dergachi, Saratov; Berezov (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Rugachev (Zasukhin, 1935: 1 - 159); Stalingrad Province: on cattle (Borzenkov and Donskov, 1933: 25 - 30; Shatas, 1952: 802 - 818), horses, sheep, dog, marmot (Shatas, 1952: 802 - 818); Stalingrad; Leninsk; Chernoyarsk (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159); Nehaevsk; Urupinsk; Nizhne-Chersk (Zasukhin, 1935: 1 - 159).

Tadzhik S. S. R. - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209), on cattle (Pavlovsky, et al., 1941: 48 - 50; Galuzo, 1943: 97 - 105; Vorobeva and Pokrovsky, 1946: 90 - 91; Galuzo, 1935: 187 - 197); northern part, on cattle (Lototsky and Pokrovsky, 1946: 64 - 74); Gissar Valley, on cattle (Galuzo, et al., 1935: 167 - 185), domestic

animals (Pavlovsky, 1945: 65 - 92); valley of Vakhash (Serdyukova, 1946: 60 - 63); Stalinabad Province: vicinity of Kafirnigan (Olenev, 1931: 249 - 261).

Turkmen S. S. R. - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209) Mervsky on horse; Peschan-Ali, on horse (Olenev, 1931: 249 - 261); Ashkhabad Province: (Vlasov, 1940: 134 - 142) Tedzhen (Olenev, 1931: 249 - 261); Mary Province: Iolotan (Olenev, 1931: 294 - 261).

Ukrainian S. S. R. - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 209 - 211); Voroshilovgrad Province: Belovodsk, on cattle, dog, wolf, fox, hedgehog (Pogorely, 1936: 533 - 537).

Uzbek S. S. R. - (Galuzo, et al., 1935: 167 - 185; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209; Gajdusek, 1953: 1 - 140), on cattle (Galuzo, 1935: 187 - 197), eastern part, on cattle (Galuzo, 1943: 97 - 105); Bukhara Province: (Schulze, 1919: 189 - 196; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125), Bukhara; Sang-Gardak (Olenev, 1931: 249 - 261) Schirobad Province: Kalinin Kolkhoz, on sheep (Pavlovsky and Bernadskaya, 1948: 25 - 40).

Crimean A. S. S. R. - (Pomerantzev, 1946: 1 - 28: Pomerantzev, 1950: 209 - 211), on domestic animals (Kurchatov, 1940: 32); Crimean State Forest Reserve, on cattle, deer, Capreolus capreolus capreolus, hare, fox, swine (Melnikova, 1953: 422 - 434).

Daghestan A. S. S. R. - (Galuzo, et al., 1935: 167 - 185), on cattle, horse, sheep (Zolotarev, 1934: 217 - 227); Baba-iurt, on horse and cattle; Khasaviurt, on cattle (Olenev and Kastrov, 1932: 28 - 30). German Volga A. S. S. R. - (Zasukhin, 1935: 1 - 159). Kara-Kalpakskaya A. S. S. R. - Delta of Amu-darya; Nukus (Olenev, 1931: 249 - 261).

Krasnodar Territory - on domestic animals (Petunin, 1948: 14). Stavropol Territory - Pyatigorsk, on cattle (Olenev and Kastrov, 1932: 28 - 30).

Caucasia - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 209 - 211); northern part (Galuzo, et al., 1935: 167 - 185). Central Asia - (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125), on cattle (Pomerantzev and Matikashvili, 1940: 100 - 133; Galuzo, 1935: 187 - 197). Far East - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 209 - 211). Lower Volga Region - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 209 - 211). Transcaspia - (Schulze, 1919: 189 - 196).

Transcaucasia - (Galuzo, 1935: 167 - 185; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209); eastern, central and southern parts, on cattle, horse, zebu, buffalo (Pomerantzev and Matikashvili, 1940: 100 - 133). Transural - (Kochetkov, 1935: 124 - 127). Turkestan - (Schulze, 1919: 189 - 196; Olenev, 1928: 84 - 96; Olenev, 1929:

305 - 314), on camel, norse, cattle (Olenev, 1931: 249 - 261).

On following hosts without definite indication of locality: cattle (Olenev, 1931: 3 - 125; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), domestic animals (Pomerantzev, 1946: 1 - 28), horse (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209; Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), swine (Pomerantzev, 1950: 206 - 209; Olenev, 1931: 3 - 125), camel (Pomerantzev, 1950: 206 - 209; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 1 - 28; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), sheep (Pomerantzev, 1950: 206 - 209; Olenev, 1931: 3 - 125; Zasukhin, 1935: 1 - 159), buffalo (Pomerantzev, 1950: 206 - 209), zebu (Pomerantzev, 1950: 206 - 209), donkey (Pomerantzev, 1950: 206 - 209; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 1 - 28), hare (Pomerantzev, 1950: 206 - 209), goat (Olenev, 1931: 3 - 125), Gazella subgutturosa (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 209 - 211), Cervus bactrianus (Pomerantzev, 1950: 209 - 211), sheep (Zasukhin, 1935: 1 - 159), man (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159).

Biology

Life history: Oviposition occurred at the end of June (Zasukhin, 1933: 31 - 46) in shaded habitats such as water meadows, pastures covered with shrubs, or under grasses growing near water (Galuzo, 1941: 92 - 109; Galuzo, 1941: 51 - 55). The newly hatched larvae sheltered in cracks in the soil until October or November when they ascended grass and eventually attached to grazing cattle (Galuzo, 1944: 92 - 109; Galuzo, 1941: 51 - 55; Zasukhin, 1933: 31 - 46). After feeding, the larvae either dropped off the host (Galuzo, 1941: 51 - 55) or hibernated on the host (Zasukhin, 1933: 31 - 46). The larvae were also reported to be capable of molting on the host (Lototsky and Pokrovsky, 1946: 64 - 74). The nymphs over-wintered on cattle in the unfed condition (Galuzo, 1941: 51 - 55; Markov, et al., 1948: 13) and after engorgement they dropped from the host between January and the end of April (Zasukhin, 1933: 31 - 46; Galuzo, 1944: 92 - 109). Some nymphs, however, engorged and dropped off the host sooner without over-wintering (Galuzo, 1944: 92 - 109). Those that dropped later from the host gave rise to adults in May and August (Lototsky and Pokrovsky, 1946: 64 - 74; Galuzo, 1944: 92 - 109) depending upon the microclimate of the pasture (Galuzo, 1944: 92 - 109). Though it was usually regarded as a one host tick (Serdyukova, 1946: 60 - 63; Pomerantzev and Matikashvili, 1940: 100 - 133; Markov,

et al., 1948: 13; Alfeev, 1951: 398 - 403; Zasukhin, 1933: 31 - 46; Shatas, 1952: 802 - 818) it was also reported to be a two host tick (Pomerantzev and Matikashvili, 1940: 100 - 133; Galuzo, 1944: 92 - 109). One generation was produced each year (Pomerantzev, 1950: 206 - 209; Galuzo, 1941: 51 - 55; Pavlovsky, et al., 1941: 48 - 50; Galuzo, 1944: 92 - 109).

Hosts of stages: Adult - cattle (Petunin, 1948: 14; Olenev, 1931: 249 - 261; Olenev, 1931: 3 - 125; Galuzo, 1935: 187 - 197; Nikolsky, 1948: 29 - 33; Zasukhin, 1935: 1 - 159; Galuzo, et al., 1935: 167 - 185; Yamashita, 1939: 602 - 609; Pomerantzev and Matikashvili, 1940: 100 - 133; Pavlovsky, et al., 1941: 48 - 50; Galuzo, 1943: 97 - 105; Galuzo, 1944: 92 - 109; Lototsky and Pokrovsky, 1946: 64 - 74; Pogorely, 1936: 533 - 537; Vorobeva and Pokrovsky, 1946: 90 - 91; Tzelishcheva, 1947: 20; Markov, et al., 1948: 13; Pomerantzev, 1950: 206 - 209; Olenev, 1930: 604 - 610; Shatas, 1952: 802 - 818; Melnikova, 1953: 422 - 434; Zasukhin, 1933: 31 - 46; Zolotarev, 1934: 217 - 227), horse (Olenev, 1931: 249 - 261; Olenev, 1931: 3 - 125; Knuth, et al., 1918: 241 - 264; Pomerantzev and Matikashvili, 1940: 100 - 133; Galuzo, 1944: 92 - 109; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209; Olenev, 1930: 604 - 610; Zasukhin, 1933: 31 - 46; Zolotarev, 1934: 217 - 227; Zasukhin, 1935: 1 - 159); camel (Olenev, 1931: 249 - 261; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209; Olenev, 1930: 604 - 610; Kolpakova and Lippert, 1932: 191 - 195; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), sheep (Olenev, 1931: 249 - 261; Olenev, 1931: 3 - 125; Pavlovsky and Bernadskaya, 1948: 25 - 40; Pomerantzev, 1950: 206 - 209; Olenev, 1930: 604 - 610; Zolotarev, 1934: 217 - 227; Zasukhin, 1935: 1 - 159), goat (Olenev, 1931: 249 - 261; Olenev, 1931: 3 - 125; Olenev, 1930: 604 - 610), Sus scrofa (Olenev, 1931: 249 - 261; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 206 - 209; Olenev, 1930: 604 - 610; Schulze, 1930: 22 - 48; Melnikova, 1953: 422 - 434), donkey (Olenev, 1931: 249 - 261; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209; Olenev, 1930: 604 - 610), man (Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), domestic animals (Pomerantzev and Matikashvili, 1940: 100 - 133; Vlasov, 1940: 134 - 142; Galuzo, 1941: 51 - 55; Pavlovsky, 1945: 65 - 92; Pomerantzev, 1946: 1 - 28), Cervus bactrianus (Serdyukova, 1946: 60 - 63; Pomerantzev, 1950: 206 - 209), zebu (Yakimov, et al., 1934: 235 - 254; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 206 - 209), buffalo (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 206 - 209), Gazella subgutturosa (Pomerantzev, 1950: 206 - 209; Olenev, 1931: 249 - 261; Pomerantzev, 1946: 1 - 28), hare (Pomerantzev, 1950: 206 -

209; Melnikova, 1953: 422 - 434), deer, Capreolus capreolus capreolus, fox (Melnikova, 1953: 422 - 434).

Nymph - domestic animals (Kurchatov, 1940: 32; Galuzo, 1941: 51 - 55), cattle (Pogorely, 1936: 533 - 537; Zasukhin, 1933: 31 - 46; Zasukhin, 1931: 275 - 282; Nikolsky, 1948: 29 - 33; Pavlovsky, et al., 1941: 48 - 50; Galuzo, 1944: 92 - 109; Pomerantzev, 1946: 1 - 28; Lototsky and Pokrovsky, 1946: 64 - 74; Tzelishcheva, 1947: 20, Markov, et al., 1948: 13; Pomerantzev, 1950: 206 - 209; Shatas, 1952: 802 - 818), dog, wolf, fox, hedgehog (Pogorely, 1936: 533 - 537), horse (Galuzo, 1944: 92 - 109; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 206 - 209; Petunin, 1948: 14).

Larva - domestic animals (Galuzo, 1941: 51 - 55; Kurchatov, 1940: 32), cattle (Pavlovsky, et al., 1941: 48 - 50; Galuzo, 1943: 97 - 105; Galuzo, 1944: 92 - 109; Lototsky and Pokrovsky, 1946: 64 - 74; Petunin, 1948: 14; Shatas, 1952: 802 - 818; Zasukhin, 1933: 31 - 46), horse (Galuzo, 1944: 92 - 109).

Seasonal activity: In Kazakh the adults infested cattle from about mid-May until the end of August. They showed a peak of abundance in June and completely disappeared in September (Galuzo, 1944: 92 - 109). The nymphs were most active in October or November (Galuzo, 1944: 92 - 109) but were also found on cattle in the winter (Zasukhin, 1931: 275 - 282). Larvae were found on cattle in October or November (Galuzo, 1944: 92 - 109).

In the Lower Volga Regions and in western Kazakh the nymphs and adults occurred throughout the November - March period. The nymphs were found in great masses up to January while the adults were present in masses in April; larvae appeared at the beginning of August (Zasukhin, 1933: 31 - 46).

In Tadzhik infestation of cattle by adults began in April, reached a peak toward the end of May or the beginning of June and ceased toward the end of September (Lototsky and Pokrovsky, 1946: 64 - 74; Galuzo, 1935: 187 - 197; Pavlovsky, 1941: 48 - 50; Galuzo, 1943: 97 - 115). The larvae and nymphs occurred on cattle between September and mid-April (Lototsky and Pokrovsky, 1946: 64 - 74; Pavlovsky, 1941: 48 - 50; Galuzo, 1943: 97 - 115) and showed four periods of infestation: September-October, November-December, December-January and February-April (Lototsky and Pokrovsky, 1946: 64 - 74).

In Uzbek the adults were found on cattle from the beginning of May to the beginning of August (Galuzo, 1935: 187 - 197; Galuzo, 1943: 97 - 115) and the larvae were present on animals in October-November (Galuzo, 1943: 97 - 115).

In Krasnodar Territory and in North Caucasus the larvae occurred in October (Markov, et al., 1948: 13) and in November and reached a

peak of abundance in January-February (Petunin, 1948: 14). The adults were present in February, March (Markov, et al., 1948: 13), April and May (Petunin, 1948: 14) and nymphs were present in February and March (Markov, et al., 1948: 13).

In Transcaucasia most adults were found in January, February and March with isolated specimens present until June; nymphs occurred from October to February; and larvae were found in November (Pomerantzev and Matikashvili, 1940: 100 - 133).

In Crimea the adults were active from September to May (Kurchatov, 1940: 32; Melnikova, 1953: 422 - 434); nymphs occurred in January - February and larvae in November - December (Melnikova, 1953: 422 - 434).

In Ukraine the nymphs and adults were numerous on cattle in the autumn and in the winter and nymphs were also found in the summer on dogs, wolves, foxes and hedgehogs (Pogorely, 1936: 533 - 537).

In Stalingrad and in the northern districts of Astrakhan the larvae began their activity in September and reached a peak of abundance in October; the nymphs were abundant from November to January with only single findings recorded in February; the adults reached a maximum in April and were practically gone by the beginning of May (Shatas, 1952: 802 - 818).

Habitats: All stages were found in grass semi-desert zone, shrub formations, forest zone (Pomerantzev and Matikashvili, 1940: 100 - 133), semi-desert zone (Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), desert zone (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Zasukhin, 1935: 1 - 159), forest steppe zone, steppe zone (Zasukhin, 1935: 1 - 159; Zasukhin, 1933: 31 - 46), and pastures of the saline marshy type (Pomerantzev, 1934: 63 - 66).

Habits: Larvae which were on animals in October - November attached to the parts of the body most exposed to the sun whereas the adults which infested animals in June - July attached on the under parts to protect themselves from the heat of the sun (Galuzo, 1943: 97 - 105).

Control Measures

To destroy eggs the pastures should be plowed or disked in May - July or else mown and the hay and undergrowth removed to expose the soil to the heat of the sun. Repeating this procedure in September or October destroyed larvae sheltering in cracks in soil, while

scorching the grass at the end of October or in November killed them while they awaited hosts. The nymphs were controlled by plowing pasture land in April or May.

Since the larvae attached between October and the end of January cattle and horses should be kept in barns during this period or allowed to graze only in pastures with fairly sparse vegetation. Attached nymphs could be destroyed by chemical treatment at the end of October and again in January. Since the nymphs dropped from the host in February, March and April, pastures grazed during these months should not be used from June to the end of August so that the resulting adults would die of starvation (Galuzo, 1944: 92 - 109; Galuzo, 1941: 51 - 55; Pavlovsky, et al., 1941: 48 - 50). Cleanliness of farm buildings helped reduce infestation (Pavlovsky, et al., 1941: 48 - 50).

Promising results were obtained in laboratory and in field tests with pyrethrum powders, having a pyrethrin content of 0.4 - 1%, used either alone or mixed with talc or ash, with water suspension of pyrethrum powder with or without the addition of kerosene and soap, with an emulsion prepared from paste having pyrethrin content of 0.06 - 0.1% and with an ointment made from pyrethrum powder and vaseline or similar substances. In the laboratory pyrethrum had a paralysing action and all preparations killed starved adults within 13 days; however, a considerable percentage of engorged nymphs and adults survived. In tests under farm conditions practically all adults were killed if they had not begun to feed; if they were feeding, however, the resistance of both nymphs and females was directly proportional to the degree of engorgement. Nymphs of Hyalomma detritum were somewhat more resistant than those of some other species tested. Ointments were particularly effective and killed practically all starved and partially engorged adults of H. detritum (Kurchatov, 1941: 97 - 103).

In laboratory tests larvae heavily dusted with DDT became incapable of movement in five hours and those dusted with BHC showed a similar reaction in three hours. The same results were observed when larvae were placed on glass and came in contact with a thin layer of dust surrounding them. When immersed for one minute in 0.01 - 0.5% suspensions of BHC all larvae were immobilized in 60 minutes by 0.1 or 0.5% but 10 - 13% survived the 0.01% suspension. The larvae were affected by all concentrations of DDT. Engorged nymphs and unfed adults thoroughly dusted with BHC or DDT died in 5 days, though some of the nymphs had transformed into adults before death. A 0.5% suspension of DDT or BHC killed all adults in 48 hours, but again some of the treated nymphs transformed into adults. In experiments on winter control the dusts of DDT or BHC were sometimes applied dry

and sometimes mixed with water (1:5 or 1:10) to prevent waste. A single application of DDT or BHC killed all nymphs and adults on the rump and prevented reinfestation for a fortnight, however, up to 10% of the ticks survived on the abdomen and hind legs where the hair was thick. Suspensions of 0.5% DDT or BHC were also effective but the treatment had to be repeated when nymphs were present. No ill effects on the animals were noted from the use of these compounds (Nikolsky, 1948: 29 - 33).

The use of a mixture made up of equal parts of kerosene and crude cotton seed oil and a 0.2% solution of sodium arsenite applied weekly during the summer had no appreciable effect upon the ticks. Also ineffective was the use of desinectalin (Lototsky and Pokrovsky, 1946: 64 - 74). Used lubricating oil was not effective as an acaricide (Vorobeva and Pokrovsky, 1946: 90 - 91).

Relation to Disease

Piroplasmosis: H. detritum transmitted Theileria to cattle in various parts of the U. S. S. R. (Galuzo, 1935: 187 - 197; Tzelishcheva, 1940: 31 - 35; Pomerantzev and Matikashvili, 1940: 100 - 133; Pavlovsky, et al., 1941: 48 - 50; Tzelishcheva, 1941: 63 - 64; Galuzo, 1943: 41 - 47; Galuzo, 1944: 92 - 109; Lototsky and Pokrovsky, 1946: 64 - 74; Markov, et al., 1948: 13) and experimentally transmitted Nuttallia equi to horses (Petunin, 1948: 14).

Haemorrhagic Fever: H. detritum was regarded as a possible vector of Uzbek Haemorrhagic Fever (Gajdusek, 1953: 1 - 140).

Plague: Adults were fed on artificially plague infected Citellus pygmaeus and virulent plague bacilli were present in their faeces or in their digestive tracts up to the 11th day. The adults transmitted infection to healthy ground squirrels apparently by biting, as indicated by an experiment in which it was impossible for the animal to eat the ticks placed on it, or to rub them or their faeces into the skin. Engorged nymphs harbored plague bacilli for 3 days and engorged larvae for 7 days and a positive plague culture was also obtained from the faeces of infected nymphs (Borzenkov and Donskov, 1933: 25 - 30). It was regarded as a possible vector of the plague bacillus (Pomerantzev, 1950: 209 - 211).

Miscellaneous: The salivary glands contained a powerful anticoagulin and emulsions prepared from such glands had a marked inhibitory effect on the coagulation of rabbit blood in vitro (Hoeppli and Feng, 1933: 29 - 43). The adults sucked up to 4 cc of blood (Zasukhin, 1933: 31 - 46).

Hyalomma dromedarii Koch

Hyalomma dromedarii Koch, 1844: 220; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Pavlovsky and Pomerantzev, 1934: 49 - 62; Pomerantzev, 1934: 63 - 66; Delpy, 1936: 206 - 245; Delpy and Gouchey, 1934: 487 - 499; Delpy, 1937: 481 - 486; Delpy and Rafyi, 1939: 45 - 61; Pomerantzev and Matikashvili, 1940: 100 - 133; Vlasov, 1940: 134 - 142; Tzelishcheva, 1940: 31 - 35; Kurchatov, 1941: 97 - 103; Galuzo, 1941: 51 - 55; Chumakov, et al., 1945: 18 - 24; Pomerantzev, 1946: 25, 27; Serdyukova, 1946: 199 - 202; Khayyat and Gilder, 1947: 119 - 126; Dubinin, 1948: 275 - 286; Pervomaisky, 1948: 35 - 40, 42 - 49; Pervomaisky, 1949: 523 - 526; Delpy, 1949: 464 - 494; Pomerantzev, 1950: 197 - 200; Alfeev, 1951: 398 - 403.

Hyalomma aegyptium dromedarii, Neumann, 1901: 313, in part; Neumann, 1911: 51, in part; Yakimov, 1917: 298 - 301.

Hyalomma asiaticum, Schulze, 1935: 180 - 181; Galuzo, 1935: 187 - 197; Delpy, 1936: 206 - 245; Blagoveshchensky, 1937: 11 - 84; Andrushko, 1939: 154 pp.; Vlasov, 1940: 134 - 142; Bernadskaya, 1939: 15 - 27; Chumakov, et al., 1945: 18 - 24; Pomerantzev, 1946: 24, 27; Serdyukova, 1946: 199 - 202; Pervomaisky, 1947: 75 - 78; Markov, et al., 1948: 13; Pervomaisky, 1948: 35 - 40; Pavlovsky and Bernadskaya, 1948: 25 - 40; Olenev, 1950: 149 - 151.

Hyalomma asiaticum asiaticum, Pomerantzev, 1946: 24, 27; Pomerantzev, 1950: 202 - 203.

Hyalomma asiaticum citripes Schulze, 1935: 178 - 186.

Hyalomma dromedarii asiaticum Schulze and Schlottke, 1929: 34 - 43; Olenev, 1930: 604 - 610; Olenev, 1930: 126 - 139; Olenev, 1931: 249 - 261; Olenev, 1931: 3 - 125; Vlasov, 1932: 89 - 102; Olenev, 1934: 367 - 388; Galuzo, 1934: 29 - 47; Kurchatov and Kalmikov, 1934: 80 pp.; Pomerantzev, 1946: 24, 27.

Hyalomma dromedarii canariense Schulze and Schlottke, 1929: 3, 14, 34, 45; Delpy, 1936: 206 - 245.

Hyalomma pavlovskyi Schulze and Schlottke, 1929: 36; Olenev, 1931: 249 - 261; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Galuzo, 1935: 187 - 197; Delpy, 1949: 464 - 494.

Hyalomma yakimovi Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1932: 195 - 212; Pospelova-Shtrom, 1935: 195 - 233; Galuzo, 1935: 187 - 197; Delpy, 1936: 206 - 245; Vlasov, 1940: 134 - 142; Serdyukova, 1946: 199 - 202; Pomerantzev, 1946: 24, 27.

Hyalomma yakimovi persiacum Olenev, 1931: 3 - 125; Olenev, 1931: 126 -

139; Delpy, 1936: 206 - 245.
? Hyalomma kozlovi Olenev, 1931: 249 - 261; Olenev, 1934: 367 - 388.
? Hyalomma asiaticum kozlovi, Pomerantzev, 1946: 24, 27; Pomerantzev, 1950: 204 - 206.

Localities and Hosts

Asia

Afghanistan - (Pomerantzev, 1946: 24, 27; Pomerantzev, 1950: 197 - 200). Asia Minor - (Pomerantzev, 1950: 197 - 200). ?China - Mongolia - Tibet - Orok Nora; Hora Hota; Etsen-gol River near Lake Sogo-nor; Baga Moto (Valley of Sogo-nor); Alashan; Oasis Dyninan-in; Alaman Desert; Eastern Tsaidam; Nan Shan Mountains; River Khuan-Khe (Olenev, 1931: 294 - 261; Olenev, 1934: 367 - 388; Pomerantzev, 1950: 204 - 206); Karakorum, Sin-tsian, from River Tschertschevska (Pomerantzev, 1950: 204 - 206), on camel (Pomerantzev, 1946: 24, 27). Iran - (Delpy, 1936: 206 - 245; Pomerantzev, 1946: 24, 27), on camel (Pospelova-Shtrom, 1932, 195 - 212); Teheran, Kozvin; Semnam (Pomerantzev, 1950: 197 - 200); Gilian (Pomerantzev, 1950: 197 - 200; Olenev, 1931: 249 - 261); Mendzhil (Olenev, 1931: 249 - 261). Iraq - (Khayyat and Gilder, 1947: 119 - 126). Kashmir - Karakorum Mountains (Schulze, 1935: 178 - 186). Syria - (Pomerantzev, 1950: 197 - 200), on Camelus dromedarius (Neumann, 1911: 51).

U. S. S. R.

Armenian S. S. R. - central part (Pavlovsky and Pomerantzev, 1934: 49 - 62); in southwestern part (Pomerantzev, 1934: 63 - 66). Azerbaijan S. S. R. - (Kurchatov, 1941: 97 - 103).

Kazakh S. S. R. - (Olenev, 1931: 126 - 139), on domestic animals (Galuzo, 1941: 51 - 55); southern part, on cattle (Tzelishcheva, 1940: 31 - 35); western, southern and eastern parts (Pomerantzev, 1946: 24, 27; Pomerantzev, 1950: 202 - 203); in various parts on camel, horse, cattle, sheep, goat, donkey, Sus scrofa (Olenev, 1930: 604 - 610); Aral Tyube, on camel (Olenev, 1931: 249 - 261); Aktyubinsk Province: Irgizo-Turgai (Olenev, 1934: 367 - 388), on camel, horse, cattle (Olenev, 1931: 249 - 261); Kzyl-Orda Province: Aral'sk (Olenev, 1934: 367 - 388), on camel and horse (Olenev, 1931: 249 - 261); Barsa Kelmes, on camel (Olenev, 1931: 249 - 261); Kazalinsk (Olenev, 1934: 367 - 388), on camel, horse, cattle, sheep, goat, donkey (Olenev, 1931: 249 - 261); Karmaktschi, on camel (Olenev, 1931: 249 - 261); Kzyl-Orda

(Olenev, 1934: 367 - 388), on camel, horse, cattle, sheep, donkey (Olenev, 1931: 249 - 261); Solotyube, on Sus scrofa (Olenev, 1931: 249 - 261); Chiili, on camel, horse, cattle, sheep and goat (Olenev, 1931: 249 - 261); Chimkent Province: Arys, on camel, horse (Olenev, 1931: 249 - 261); Alma Ata Province: on camel, cattle, sheep (Olenev, 1931: 249 - 261); Dzharkent, on horse (Olenev, 1934: 367 - 388); Dzhambul Province: Talass River, 50 km. from Schapovalovka, on horse (Olenev, 1931: 249 - 261); Novo-Troitskoye (Olenev, 1934: 367 - 388); on camel, sheep, horse, cattle (Olenev, 1931: 249 - 261); Merke, on horse (Olenev, 1931: 249 - 261); Karaganda Province: Dzheras-Kazgan (Olenev, 1931: 249 - 261); Taldy Kurgan Province: Lepsa, on camel, cattle (Olenev, 1934: 367 - 388); Kesken on Kara-Tal River, on sheep (Olenev, 1931: 249 - 261).

Kirghiz S. S. R. - Issyk-Kul Province: Tschundzhen post (Olenev, 1931: 249 - 261). R. S. F. S. R. - (Chita Province: on camels from western Mongolia (Dubinin, 1948: 275 - 286). Tadzhik S. S. R. - (Pomerantzev, 1946: 24, 27; Pomerantzev, 1950: 202 - 203), southern part (Pomerantzev, 1946: 24, 27; Pomerantzev, 1950: 197 - 200).

Turkmen S. S. R. - (Pomerantzev, 1946: 24, 27; Pomerantzev, 1950: 197 - 200); Kara Kum Desert (Vlasov, 1940: 134 - 142), on Allactaga severtzovi, Lepus tolai and domestic animals (Andrushko, 1939: 154 pp.). Ashkhabad Province: in vicinity of Ashkhabad, in nests of Rhombomys opimus and Spermophilopsis leptodactylus (Vlasov, 1932: 89 - 102; Vlasov, 1940: 134 - 142), in nests of sand rat, Pallasiomys, on Pallasiomys and hedgehog (Vlasov, 1940: 134 - 142), Serakh district, on wild boar (Vlasov, 1940: 134 - 142); vicinity of Stantsiya Archman (Vlasov, 1940: 134 - 142); vicinity of Krasnovodsk; Bol'shoy Balkhan Mountains; Perevalnoe; Bakharden; Ashkabad; Anau; Giaurs; Tedzhen (Olenev, 1931: 249 - 261); Gasan-kuli, on cattle (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125). Mary Province: Kushka (Olenev, 1931: 3 - 125), on cattle (Olenev, 1931: 126 - 139); Bairam-ali; Uch-Adzhi (Olenev, 1931: 249 - 261); Chardzhou Province: Repetek, on camel, donkey (Olenev, 1931: 249 - 261).

Uzbek S. S. R. - (Pervomaisky, 1947: 75 - 78; Pomerantzev, 1950: 202 - 203); southern part (Pomerantzev, 1946: 24, 27; Pomerantzev, 1950: 197 - 200); Bukhara Province: (Olenev, 1929: 305 - 311), on Camelus dromedarius (Olenev, 1928: 84 - 98; Neumann, 1911: 51); Karakul district, on camel (Pavlovsky and Bernadskaya, 1948: 25 - 40); Starya Bukhara, on camel; Kharoussch; Bova-Abzal; Kischlak Gillian; Sang-gardok, southern part (Olenev, 1931: 249 - 261); Fergana Province: (Pomerantzev, 1946: 24, 27), Fergana; vicinity of Fedchenka (Olenev, 1931: 249 - 261).

Kara-Kalpakskaya A. S. S. R. - Delta of Amu-Darya; vicinity of

Kaschpyrrovat (Olenev, 1931: 249 - 261). Nakhichevanskaya A. S. S. R. Dzhul'fa, on camels (Pomerantzev and Matikashvili, 1940: 100 - 133).

Caucasia - southern part (Olenev, 1931: 3 - 125). Central Asia - (Olenev, 1931: 126 - 139), on camel, horse, donkey, sheep, goat, boar (Olenev, 1931: 3 - 125), cattle (Galuzo, 1934: 29 - 47; Olenev, 1931: 3 - 125). Transcaucasia - (Olenev, 1931: 249 - 261; Olenev, 1931: 126 - 139). Turkestan - (Olenev, 1929: 305 - 314), on camel (Olenev, 1928: 84 - 96; Olenev, 1931: 249 - 261), horse (Yakimov, 1917: 298 - 301; Olenev, 1931: 249 - 261).

On following hosts without definite indication of locality: cattle (Pomerantzev, 1946: 24, 27; Pomerantzev, 1950: 197 - 200, 202 - 203; Olenev, 1931: 3 - 125), camel (Pomerantzev, 1946: 24, 27; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 197 - 200, 202 - 203), horse (Pomerantzev, 1950: 197 - 200, 202 - 203), sheep (Pomerantzev, 1950: 197 - 200, 202 - 203), boar (Pomerantzev, 1946: 24, 27; Pomerantzev, 1950: 202 - 203), rabbit (Pomerantzev, 1946: 24, 27; Pomerantzev, 1950: 202 - 203), man (Pomerantzev, 1946: 24, 27; Pomerantzev, 1950: 202 - 203), goats, donkeys, Hemiechinus albulus turanicus, marmots (Pomerantzev, 1950: 202 - 203).

Biology

Life history: Oviposition occurred in holes or lairs of Spermophilopsis leptodactylus; sand rats and other animals and about 10,000 eggs were deposited. The larvae and nymphs led a sheltered life in these same situations and fed upon the inhabitants. The adults left the holes when climatic conditions were favorable and attacked large animals on which they copulated and fed (Vlasov, 1940: 134 - 142).

The length of the life cycle depended more on the temperature of the host's body than on that of the atmosphere. Most rapid development occurred at 28 - 39° C. and the time required for each stage increased with a decrease in temperature (Pospelova-Shtrom, 1932: 195 - 212). During the hot season the cycle was completed in 93 days but in colder weather 280 days or more were required. Two generations occurred in one year and the short summer cycle alternated with the long winter one. The longer cycle was due to an increased incubation period and a lengthening of the period from engorging to molting or ovipositing, whereas the times of engorging of all stages were almost constant (Delpy and Gouchey, 1934: 487 - 499).

H. dromedarii was normally a three host tick but occasionally completed its development on one or two hosts (Delpy and Gouchey, 1937: 487 - 499; Serdyukova, 1946: 199 - 202; Alfeev, 1951: 398 - 403;

Pospelova-Shtrom, 1932: 195 - 212). When development was confined to one rabbit the newly molted nymphs and adults moved to new positions and an interval of a day or two appeared obligatory before reattachment (Alfeev, 1951: 398 - 403).

Hosts of stages: Adult - camel (Pomerantzev, 1950: 197 - 200, 202 - 203; Pomerantzev, 1946: 24, 27; Pavlovsky and Bernadskaya, 1948: 25 - 40; Olenev, 1931: 3 - 125; Olenev, 1931: 249 - 261; Olenev, 1930: 604 - 610; Delpy and Gouchey, 1937: 487 - 499; Dubinin, 1948: 275 - 286; Neumann, 1911: 51), cattle (Pomerantzev, 1950: 197 - 200, 202 - 203; Olenev, 1931: 3 - 125; Olenev, 1931: 249 - 261; Olenev, 1930: 604 - 610; Delpy and Gouchey, 1937: 487 - 499; Pomerantzev, 1946: 24, 27; Olenev, 1931: 126 - 139), horses (Pomerantzev, 1950: 197 - 200, 202 - 203; Olenev, 1931: 3 - 125; Olenev, 1931: 249 - 261; Olenev, 1930: 604 - 610; Yakimov, 1917: 298 - 301), sheep (Pomerantzev, 1950: 197 - 200, 202 - 203; Olenev, 1931: 3 - 125; Olenev, 1931: 249 - 261; Olenev, 1930: 604 - 610), goats (Pomerantzev, 1950: 202 - 203; Olenev, 1931: 3 - 125; Olenev, 1931: 249 - 261; Olenev, 1930: 604 - 610), donkey (Pomerantzev, 1950: 202 - 203; Olenev, 1931: 3 - 125; Olenev, 1931: 249 - 261; Olenev, 1930: 604 - 610), swine (Pomerantzev, 1950: 202 - 203; Pomerantzev, 1946: 24, 27; Olenev, 1931: 3 - 125; Olenev, 1931: 249 - 261; Olenev, 1930: 604 - 610), Hemiechinus albulus turanicus (Pomerantzev, 1950: 202 - 203), hare (Pomerantzev, 1950: 202 - 203; Pomerantzev, 1946: 24, 27), man (Pomerantzev, 1950: 202 - 203; Pomerantzev, 1946: 24, 27), domestic animals (Galuzo, 1941: 51 - 55), Allactaga severtzovi, Lepus tolai (Andrushko, 1939: 154 pp.), wild boar (Vlasov, 1940: 134 - 142).

Nymph - camel (Delpy and Gouchey, 1937: 487 - 499; Pomerantzev, 1950: 197 - 200), cattle (Delpy and Gouchey, 1937: 487 - 499; Pomerantzev, 1946: 24, 27; Pomerantzev, 1950: 197 - 200), domestic animals (Galuzo, 1941: 51 - 55), Pallasiomys (Vlasov, 1940: 134 - 142), hedgehog (Vlasov, 1940: 134 - 142; Pomerantzev, 1950: 202 - 203), marmot (Pomerantzev, 1950: 202 - 203).

Larva - hedgehog (Pomerantzev, 1950: 202 - 203).

Seasonal activity: The adults were active in January, March, April, May, July, August, September and October (Pomerantzev, 1950: 197 - 200, 202 - 203). The nymphs and larvae were found from March to August (Pomerantzev, 1950: 197 - 200, 202 - 203).

Habitats: All stages were found in the semi-desert and desert zones of the foothills of mountains in Central Asia (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Pomerantzev, 1934: 63 - 66; Vlasov, 1940: 134 - 142).

Parasites and predators: Bernadskaya obtained 24 Hunterellus hookeri from one nymph of H. dromedarii taken in Uzbek. (Pervomaisky,

1947: 75 - 78). Many species of Reduviidae, Carabidae and Histeridae were found in the holes and lairs of Spermophilopsis leptodactylus and sand rats where larvae and nymphs of H. dromedarii developed. It was thought that these insects prevented the mass reproduction of this species by eating larvae and nymphs (Vlasov, 1940: 134 - 142).

Control Measures

Pyrethrum was tested against ticks on domestic animals under farm conditions in the laboratory. Pyrethrum powders having a pyrethrin content of 0.4 - 1% were used either alone or mixed with talc or ash, as water suspensions of pyrethrum powder with or without the addition of kerosene and soap, as an emulsion prepared from paste having a pyrethrin content of 0.06 - 0.1% and, as ointments made from pyrethrum powder and vaseline or similar substances. Under farm conditions only single individuals of H. dromedarii survived. If they were feeding, however, the resistance of both nymphs and females was directly proportional to the degree of engorgement. Of several species tested H. dromedarii was the most resistant. Pyrethrum powders were also found to prevent reinfestation as 50% of H. dromedarii died when placed on animals 2 - 48 hours after treatment (Kurchatov, 1941: 97 - 103). In winter tests volatile fractions of buds of Prudus padus killed larvae of H. dromedarii in 10 - 12 minutes while the bark killed them in 10 - 15 minutes (Olenev, 1950: 149 - 151).

Relation to Disease

Piroplasmosis - H. dromedarii transmitted Theileria naturally and experimentally to cattle (Tzelishcheva, 1940: 31 - 35; Markov, et al., 1948: 13; Galuzo, 1934: 29 - 47; Olenev, 1931: 3 - 125).

Encephalitis - When H. dromedarii fed on laboratory rodents infected with spring-summer encephalitis the virus persisted in this species for 15 months and was transmitted through the eggs to the larvae of the second and third generations. The virus of Japanese (mosquito-borne) encephalitis was transmitted to larvae of the second generation (Chumakov, et al., 1945: 18 - 24).

Relapsing Fever - Nymphs of H. dromedarii fed as larvae on a rabbit infected with relapsing fever did not harbor the spirochaetes (Delpy and Rafyi, 1939: 45 - 61).

Hyalomma excavatum Koch

Hyalomma excavatum Koch, 1844: 220 - 222.
Hyalomma anatolicum Koch, 1844: 220 - 221; Olenev, 1930: 604 - 610; Olenev, 1931: 126 - 139; Olenev, 1931: 249 - 261; Bernadskaya, 1939: 15 - 27; Pomerantzev and Matikashvili, 1940: 100 - 133; Kurchatov, 1941: 97 - 103; Lagereva, 1946: 9 - 14; Vorobeva and Pokrovsky, 1946: 90 - 91; Lototzky and Pokrovsky, 1946: 64 - 74; Blagoveshchensky and Serdyukova, 1946: 75 - 89; Serdyukova, 1946: 60 - 63; Pomerantzev, 1946: 24, 27; Serdyukova, 1946: 199 - 202; Markov, et al., 1948: 13; Pomerantzev, 1950: 212 - 214; Gajdusek, 1953: 1 - 140.
Hyalomma amurense Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev, 1934: 367 - 388.
Hyalomma anatolicum excavatum, Serdyukova, 1941: 135 - 144; Pomerantzev, 1946: 24, 27; Blagoveshchensky and Serdyukova, 1946: 75 - 89; Markov, et al., 1948: 13; Pervomaisky, 1949: 523 - 526; Pomerantzev, 1950: 214.
Hyalomma asiaticum caucasicum Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 203 - 204.
Hyalomma rhipicephaloides Neumann, 1901: 317 - 318; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314.
Hyalomma savignyi, Galuzo, 1944: 92 - 109.
NOT Hyalomma anatolicum, Galuzo, 1944: 92 - 109 = Hyalomma savignyi (Gervais).
? Hyalomma turkmeniense Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Kornienko and Shmuireva, 1944: 24 - 25; Chumakov, et al., 1945: 18 - 24; Pomerantzev, 1946: 1 - 28; Markov, et al., 1948: 13.

Localities and Hosts

Europe

Europe - southern part (Olenev, 1931: 126 - 139). Asia - Asia Minor (Olenev, 1931: 126 - 139). Iran, (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 214).

U. S. S. R.

Armenian S. S. R. - (Pomerantzev and Matikashvili, 1940: 100 -

133). R. S. F. S. R. - Amur Province (Olenev, 1934: 367 - 388; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139). Kazakh S. S. R. - southern part (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 212 - 214); southeastern part, on camel, horse, cattle (Olenev, 1930: 604 - 610); Kzyl Orda Province: Dzhalagash on horse; Chimkent Province: Arys, on camel, horse, cattle; Chimkent, on camel, horse, cattle; Alma Ata Province: Aulie Ata, on camel (Olenev, 1931: 249 - 261). Tadzhik S. S. R. - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 212 - 214), on cattle (Blagoveshchensky and Serdyukova, 1946: 75 - 89; Vorobeva and Pokrovsky, 1946: 90 - 91); Gissar Valley (Serdyukova, 1946: 199 - 202), on cattle (Serdyukova, 1946: 60 - 63); northern part, near Fergana, on cattle (Lototzky and Pokrovsky, 1946: 64 - 74). Turkmen S. S. R. - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 212 - 214); Ashkhabad Province: Gasan-kuli (Olenev, 1931: 3 - 125). Uzbek S. S. R. - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 212 - 214), from Termiz to Tashkent (Gajdusek, 1953: 1 - 140). Daghestan A. S. S. R. - (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 212 - 214). Caucasus - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314). Central Asia - (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125), on cattle (Kornienko and Shmurieva, 1944: 24 - 25). Transcaucasia - southern and eastern parts (Pomerantzev, 1946: 1 - 28; Pomerantzev, 1950: 212 - 124), on cattle, zebu, buffalo, horse, donkey, camel, sheep, goat, hare (Pomerantzev and Matikashvili, 1940: 100 - 133). Turkestan - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314), on camel, horse (Olenev, 1931: 249 - 261).

On following hosts without definite indication of locality: large mammals (Pomerantzev, 1946: 1 - 28), cattle, horses (Pomerantzev, 1950: 212 - 214), camel, sheep (Olenev, 1931: 3 - 125).

Biology

Life history: Oviposition occurred in July and August about a week after the female dropped from the host and it lasted 15 to 19 days. The eggs hatched in 23 to 26 days. The larvae completed feeding in 2 to 4 days and molted 6 to 12 days later. Unfed larvae survived in unheated animal quarters. The nymphs completed engorgement in 4 1/2 to 6 days and molted 12 to 20 days later. Larvae and nymphs detached from the host at night with most of them dropping between 9 and 11 P. M. This behavior probably protected the ticks from exposure to the direct rays of the sun. Unfed males and females and engorged females underwent a diapause in the winter (Serdyukova, 1946: 73 - 74). This species was normally a three host tick (Serdyukova,

1946: 73 - 74) but on unusual hosts it also behaved as a two host tick (Lototzky and Pokrovsky, 1946: 64 - 74; Serdyukova, 1946: 199 - 202).

Hosts of stages: Adult - domestic animals (Pomerantzev, 1946: 1 - 28), hare (Pomerantzev, 1946: 1 - 28; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 203 - 204), sheep (Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 203 - 204), horse (Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1930: 604 - 610; Olenev, 1931: 249 - 261; Pomerantzev, 1950: 212 - 214), cattle (Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1930: 604 - 610; Olenev, 1931: 249 - 261; Vorobeva and Pokrovsky, 1946: 90 - 91; Lototzky and Pokrovsky, 1946: 64 - 74; Serdyukova, 1946: 60 - 63; Pomerantzev, 1950: 212 - 214; Kornienko and Shmuireva, 1944: 24 - 25), buffalo (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 203 - 204), camel (Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1930: 604 - 610; Olenev, 1931: 249 - 261; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 203 - 204), goat (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 203 - 204), donkey (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 203 - 204), zebu (Pomerantzev and Matikashvili, 1940: 100 - 133).

Nymph - cattle (Pomerantzev and Matikashvili, 1940: 100 - 133; Lototzky and Pokrovsky, 1946: 64 - 74; Serdyukova, 1946: 60 - 63), sheep, goats (Pomerantzev and Matikashvili, 1940: 100 - 133).

Larva - cattle (Pomerantzev and Matikashvili, 1940: 100 - 133; Galuzo, 1944: 92 - 109; Lototzky and Pokrovsky, 1946: 64 - 74; Serdyukova, 1946: 60 - 63), sheep (Pomerantzev and Matikashvili, 1940: 100 - 133).

Seasonal activity: In Transcaucasia the adults were active from March to October; the nymphs were present from July to October; and the larvae were found in July, August and September (Pomerantzev and Matikashvili, 1940: 100 - 133). In Uzbek the adults were active the entire year and reached a maximum abundance in May, June and July; the larvae and nymphs were found from April to November and showed a peak of abundance in July and August (Pomerantzev, 1950: 212 - 214). In Tadzhik the adults infested cattle from February to the end of November; larvae and nymphs were present in July, August and September and like the adults were most numerous in the first ten days of August (Lototzky and Pokrovsky, 1946: 64 - 74).

Habitats: All stages were found in semi-desert zones, in semi-steppe zones extending to shrub formations, in forest zones and in mountain steppe zones (Pomerantzev and Matikashvili, 1940: 100 - 133). They were also found in the cracks of clay walls and in the wooden

parts of cattle sheds and enclosures (Serdyukova, 1946: 60 - 63).

Control Measures

Acaricidal tests against H. excavatum were made with pyrethrum powders having a pyrethrin content of 0.4 - 1% used either alone or mixed with talc or ash, with water suspensions of pyrethrum powders with or without the addition of kerosene and soap, with an emulsion prepared from a paste having a pyrethrin content of 0.06 - 0.1% and with ointments made from pyrethrum powder and vaseline or similar substances (Kurchatov, 1941: 97 - 103). Under farm conditions all adults were killed if they had not begun to feed but if they had begun to feed the resistance of both nymphs and females was directly proportional to the degree which they had engorged. (Kurchatov, 1941: 97 - 103; Blagoveshchensky and Serdyukova, 1946: 75 - 89). No toxicity was observed on females that had partly engorged even after a second application (Blagoveshchensky and Serdyukova, 1946: 75 - 89). Pyrethrum powders also prevented reinfestation as adults died when placed on animals 2 - 48 hours after treatment (Kurchatov, 1941: 97 - 103). Good results were also obtained by dipping animals in a 2% suspension of pyrethrum powder (0.4% pyrethrins) with a 0.09% As_2O_3 (Lagereva, 1946: 9 - 14). Satisfactory results were achieved with the use of 0.18 - 0.2% solutions of sodium arsenite applied by brush or spray at intervals of six days (Lototzky and Pokrovsky, 1946: 64 - 74).

Of various substances tested for repellent action, liquid carbolic acid, lysol, naptha-lysol, creolin, tar, mint oil, turpentine, aniseed oil, clove oil, ethyl aceto-acetate, coriander oil and a pinene obtained from juniper oil were more or less effective. Of the diluted preparations applied in practice the most effective were 10 - 30% carbolic acid, lysol, naptha-lysol or creolin in water. In field tests naptha-lysol was the only material to give promising results and it apparently repelled and killed ticks; it was more effective in ointment form than in water (Blagoveshchensky and Serdyukova, 1946: 75 - 89). Used lubricating oil brushed on cattle exhibited little repellent effect (Vorobeva and Pokrovsky, 1946: 90 - 91).

To reduce tick infestation of ticks around farm buildings it was recommended that wooden structures in cattle yards be made portable and be cleaned and moved to different places periodically (Serdyukova, 1946: 60 - 63). Hand cleaning of cattle, cleaning of cattle yards and the tranfer of cattle to uninfected winter quarters partially helped to reduce tick numbers (Lototzky and Pokrovsky, 1946: 64 - 74).

Relation to Disease

Piroplasmosis - H. excavatum transmitted Theileria to cattle (Lototzky, and Pokrovsky, 1946: 64 - 74) and passed it from one generation to the next (Markov, et al., 1948: 13; Kornienko and Shmuireva, 1944: 24 - 25). Though H. turkmeniense (a questionable synonym of H. excavatum) was reported to be incapable of passing Theileria to the next generation (Markov, et al., 1948: 13) it experimentally transmitted the infection to the next generation (Kornienko and Shmuireva, 1944: 24 - 25).

Haemorrhagic Fever - In Uzbek and in other parts of Soviet Central Asia it was regarded as a vector of Uzbek Haemorrhagic Fever to man (Gajdusek, 1953: 1 - 140).

Encephalitis - In experimental studies ticks were allowed to feed on laboratory rodents infected with viruses of spring-summer encephalitis and Japanese (mosquito-borne) encephalitis. The virus of spring-summer encephalitis persisted in H. excavatum for 11 months and that of Japanese encephalitis for 25 1/2 months. The virus of spring-summer encephalitis was transmitted through the eggs to the adults of the second generation and the virus of Japanese encephalitis was passed on by the adults to the adults of the third generation. Transmission of the spring-summer encephalitis virus also occurred through the bites of the ticks but Japanese encephalitis was not so transmitted (Chumakov, et al., 1945: 18 - 24).

Relapsing Fever - Adults were fed on a guinea pig infected with the Stalinabad strain of relapsing fever and when suspensions of these ticks were injected into healthy guinea pigs it was found that they did not retain the spirochaetes for more than 24 hours (Serdyukova, 1941: 135 - 144).

Hyalomma rufipes Koch

Hyalomma rufipes Koch, 1844: 221; Pomerantzev, 1946: 1 - 28; Delpy, 1949: 464 - 494.

Hyalomma aequipunctatum Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Galuzo and Bespalov, 1935: 199 - 204; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28; Delpy, 1949: 464 - 494.

Hyalomma impressum, Pomerantzev and Matikashvili, 1940: 100 - 133.

Hyalomma marginatum impressum, Pomerantzev, 1946: 1 - 28.

Localities and Hosts

Kazakh S. S. R. - Chimkent Province: Arys (Pomerantzev, 1946: 1 - 28), on camel (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125), Dzhambul Province: Novo Troitskoye (Pomerantzev, 1946: 1 - 28), on camel (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125). Tadzhik S. S. R. - Gissar Valley, on cattle (Galuzo and Bespalov, 1935: 169 - 204). R. S. F. S. R. - Astrakhan Province (Pomerantzev, 1946: 1 - 28). Transcaucasia - Elenendorf (Pomerantzev, 1946: 1 - 28), on zebu (Pomerantzev and Matikashvili, 1940: 100 - 133).

Biology

Hosts of stages: In the U. S. S. R. this species was known only from a few single records and in each case only the male was found (Pomerantzev, 1946: 1 - 28; Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125). Males were found on camel (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125) and zebu (Pomerantzev and Matikashvili, 1940: 100 - 133).

Habitat: This species occurred in the desert and semi-desert of the foot hills of Central Asiatic mountains (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125).

Hyalomma savignyi (Gervais)

Argas savignyi Gervais, 1844: 232.
Hyalomma savignyi, Zolotarev, 1934: 217 - 227; Galuzo, 1935: 187 - 197; Mlinac and Oswald, 1936: 415 - 421; Delpy, 1936: 206 - 245; Oswald, 1937: 265 - 273; Dojmi, 1939: 400 - 403; Tzelishcheva, 1940: 31 - 35; Galuzo, 1941: 51 - 55; Tzelishcheva, 1941: 63 - 64; Bernadskaya, 1943: 32; Zotova and Balditzina, 1943: 48 - 49; Galuzo, 1943: 41 - 47; Bernadskaya, 1944: 44; Pavlovsky, 1945: 65 - 92; Pavlovsky and Bernadskaya, 1948: 25 - 40.
Hyalomma anatolicum, Galuzo, 1944: 92 - 109.
NOT Hyalomma savignyi, Galuzo, 1944: 92 - 109, = H. excavatum Koch.
Hyalomma marginatum Koch, 1844: 221; Koch, 1847: 46; Neumann, 1911: 53; Olenev, 1930: 604 - 610; Olenev, 1931: 249 - 261; Olenev and Kastrov, 1932: 28 - 30; Zasukhin, 1933: 31 - 46; Pomerantzev, 1934: 63 - 66; Yakimov, et al., 1934: 235 - 254; Zolotarev, 1934: 217 - 227; Pavlovsky and Pomerantzev, 1934: 49 - 62; Olenev,

1934: 367 - 388; Lototzky and Popov, 1934: 67 - 80; Galuzo, 1935: 187 - 197; Galuzo, et al., 1935: 167 - 185; Zasukhin, 1935: 1 - 159; Galuzo and Bespalov, 1935: 199 - 204; Agriinsky, 1938: 1 - 9; Pomerantzev and Matikashvili, 1940: 100 - 133; Tzelishcheva, 1940: 31 - 35; Markov, et al., 1940: 33; Kurchatov, 1940: 32; Vlasov, 1940: 134 - 142; Kurchatov and Sokolov, 1940: 35; Tzelishcheva, 1941: 63 - 64; Agriinsky, 1941: 56 - 57; Kurchatov, 1941: 97 - 103; Galuzo, 1941: 51 - 55; Serdyukova, 1941: 135 - 144; Zotova and Balditzina, 1943: 48 - 49; Demidov, 1944: 22; Pavlovsky, 1945: 65 - 92; Lagereva, 1946: 9 - 14; Pomerantzev, 1946: 1 - 28; Grobov, 1946: 59 - 63; Blagoveshchensky and Serdyukova, 1946: 75 - 89; Chumakov, 1948: 268 - 271; Markov, et al., 1948: 13; Pavlovsky and Bernadskaya, 1948: 25 - 40; Piontkovskaya, 1949: 419 - 420; Korshunova and Petrova-Piontkovskaya, 1949: 186 - 187; Pervomaisky, 1949: 523 - 525; Bilibin, 1950: 200 - 207; Pavlov and Guorguiev, 1950: 107 - 118; Viskovsky, 1951: 386 - 388; Gajdusek, 1953: 1 - 140.

Hyalomma marginatum bacuense Schulze and Schlottke, 1929: 32 - 46; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28.

Hyalomma marginatum balcanicum Schulze and Schlottke, 1929: 32 - 46; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Kurchatov and Kalmikov, 1934: 80 pp.; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28.

Hyalomma marginatum caspium Schulze and Schlottke, 1929: 32 - 46; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28.

Hyalomma marginatum olenevi Schulze and Schlottke, 1929: 32 - 46; Olenev, 1931: 249 - 261; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28.

Hyalomma transcaucasicum Olenev, 1934: 367 - 388; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28.

Localities and Hosts

Europe

Bulgaria - (Pavlov and Guorguiev, 1950: 107 - 118). Jugoslavia - (Mlinac and Oswald, 1936: 415 - 421; Oswald, 1937: 265 - 273). Herzegovina, on man (Dojmi, 1939: 400 - 403).

Asia

Asia Minor - (Pomerantzev, 1946: 1 - 28). Iran - Muan, in Savelan Mountains (Olenev, 1934: 367 - 388).

U. S. S. R.

Armenian S. S. R. - (Olenev, 1931: 249 - 261), on zebu (Yakimov, et al., 1934: 235 - 254); southwestern part (Pomerantzev, 1934: 63 - 66); central part (Pavlovsky and Pomerantzev, 1934: 49 - 62); northeastern part on cattle, buffalo, pig, sheep (Lototzky and Popov, 1934: 67 - 80).

Azerbaijan S. S. R. - (Kurchatov, 1941: 97 - 103); Lenkoran (Olenev, 1931: 249 - 261); Baku (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139).

Georgian S. S. R. - Kutaisi; Tkibuli; Tibilisi; Lagodekhi; Eldar; Signakhi (Olenev, 1931: 249 - 261).

Kazakh S. S. R. - (Olenev, 1931: 126 - 139: Olenev, 1931: 3 - 125), domestic animals (Galuzo, 1941: 51 - 55; Pavlovsky, 1945: 65 - 92), cattle, horse, sheep, (Galuzo, 1944: 92 - 109), birds (Pavlovsky, 1945: 65 - 92); Kum-Kuduk, on camel; Aral Sea, vicinity of Barsa-Kelmes, on camel; Aral-Tyube, on horse (Olenev, 1931: 249 - 261); southern part, on cattle (Tzelishcheva, 1940: 31 - 35; Tzelishcheva, 1941: 63 - 64); western part, in Port Arthur of Slomikhin District, on camel (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159); southeastern part, on camel, horse, cattle, sheep (Olenev, 1930: 604 - 610); Aktyubinsk Province: Irgiz (Olenev, 1934: 367 - 388), on camel (Olenev, 1931: 249 - 261); Kustanay Province: Turgai (Olenev, 1934: 367 - 388), on camel (Olenev, 1931: 249 - 261); Kzyl-Orda Province: Chiili, on camel (Olenev, 1931: 249 - 261); Chimkent Province: Arys, on camel, horse, cattle; Chimkent, on horse, cattle sheep (Olenev, 1931: 249 - 261); Dzhambul Province: Lugovoy, on horse; Novo-Troitskoye, on camel; Merke, on horse (Olenev, 1931: 249 - 261).

Kirghiz S. S. R. - Frunze Province: Frunze, on cattle (Olenev, 1931: 249 - 261).

R. S. F. S. R. - Astrakhan Province: (Pomerantzev, 1946: 1 - 28); Astrakhan on cattle, sheep, camel (Zasukhin, 1935: 1 - 159); Grozny Province: Kizliar (Olenev, 1931: 249 - 261); Kolkhoz "Lighthouse of Revolution," on cattle (Olenev and Kastrov, 1932: 28 - 30); Achikulak on cattle; Chernyy Rynok, on cattle; Talovka, on cattle; Razdolnoe, on cattle (Olenev and Kastrov, 1932: 28 - 30); Saratov Province: Dergachevsk and Novouzensk, on cattle, sheep, camel (Zasukhin, 1935: 1 - 159).

Tadzhik S. S. R. - (Blagoveshchensky and Serdyukova, 1946: 75 - 89); Gissar Valley (Galuzo, et al., 1935: 167 - 185).

Ukrainian S. S. R. - (Pomerantzev, 1946: 1 - 28); Kherson Province - Askaniya Nova, on horse (Olenev, 1931: 249 - 261; Olenev, 1931: 3 - 125), sheep, cattle (Olenev, 1931: 3 - 125); Izmail Province: Fidouisi Island near Danube Estuary (Olenev, 1931: 249 - 261).

Uzbek S. S. R. - (Bernadskaya, 1943: 32); Uteh-turgan; Kolkhoz Admu-babaeva, on cattle (Pavlovsky and Bernadskaya, 1948: 25 - 40); Tashkent Province: Tashkent, on horse (Agriinsky, 1938: 1 - 19); Fergana Province: Marchamatsky District, Kolkhoz "Red Ploughman," on cattle; Kolkhoz "Name of Stalin," on horse (Pavlovsky and Bernadskaya, 1948: 25 - 40); Bukhara Province: Baisan District, Kolkhoz Lena, on cattle; Kolkhoz Bainol-abad, on cattle (Pavlovsky and Bernadskaya, 1948: 25 - 40).

Abkhazskaya A. S. S. R. - Sukumi (Olenev, 1934: 367 - 388; Olenev, 1931: 249 - 261); Khosta (Olenev, 1931: 249 - 261).

Crimean A. S. S. R. - (Pomerantzev, 1946: 1 - 28; Piontkovskaya, 1949: 419 - 420), on horse (Markov, et al., 1940: 33; Grobov, 1946: 59 - 63; Kurchatov and Sokolov, 1940: 35), domestic animals (Kurchatov, 1940: 32), sheep, Grus grus, Melanocorypha calandra, Perdix perdix, domestic fowl, sparrows (Grobov, 1946: 59 - 63); cattle (Grobov, 1946: 59 - 63; Korshunova-Piontkovskaya, 1949: 186 - 187), hare, birds, (Korshunova and Piontkovskaya, 1949: 186 - 187), man (Chumakov, 1948: 268 - 271; Grobov, 1946: 59 - 63; Bilibin, 1950: 200 - 207; Gajdusek, 1953: 1 - 140; Viskovsky, 1951: 386 - 388), Lepus europaeus transsylvanicus (Gajdusek, 1953: 1 - 140; Grobov, 1946: 59 - 63; southern shore: Yevpatoriya; Beilous; Simferopol; Novo-Alexandrovko; Belhek; Sevastopol; Boti-liman, on horse, cattle; Mukhalatka; Kekeneiz; Biuklambat; Novy Svet; Sudaksk; Karadag Summit; Koktebel; Kertsk; Sovkhoz Mariental, on horse, sheep, swine; Sovkhoz Keniges, on camel; Sovkhoz Tschitopole, on cattle (Olenev, 1931: 249 - 261).

Daghestan A. S. S. R. - on cattle, horse, camel, sheep (Zolotarev, 1934: 217 - 227); Bakil; Khasav-iurt (Olenev, 1931: 249 - 261); Baba-iurt, on cattle; Khasav-iurt, on cattle; Stalin-aul, on cattle; Buinak, on cattle; Berikei, on horse; Derbent, on horse; DNKZ veterinary district on sheep; Artel "Way to Socialism," on sheep (Olenev and Kastrov, 1932: 28 - 30).

Kabardkinskaya A. S. S. R. - Terekli; Mekteb; Karanogai Steppe (Olenev, 1931: 249 - 261).

Krasnodar Territory - Novorossiysk; Satschi (Olenev, 1931: 249 - 261).

Caucasia - (Pomerantzev, 1946: 1 - 28; Olenev, 1931: 3 - 125;

Olenev, 1931: 126 - 139), Asche (Olenev and Kastrov, 1932: 28 - 30); northern part (Demidov, et al., 1944: 22), Tuschilovka (Olenev, 1931: 249 - 261); Aksai, on cattle; Ust Saltansky, on cattle (Olenev and Kastrov, 1932: 28 - 30). Central Asia - (Agriinsky, 1941: 56 - 57). Lower Volga Region (Pomerantzev, 1946: 1 - 28).

Transcaucasia - on sheep (Lagereva, 1946: 9 - 14); Elizavetpole; Zurnabad; Aresh (Olenev, 1931: 249 - 261); western, central, eastern and southern parts, on cattle, zebu, buffalo, horse, donkey, camel, sheep, goat, dog, swine, Galerida cristata caucasica, Passer sp., Upupa epops, Pica sp., (Pomerantzev and Matikashvili, 1940: 100 - 133). Turkestan - on camel, horse, sheep (Olenev, 1931: 249 - 261).

On following hosts without definite indication of locality: domestic animals (Pomerantzev, 1946: 1 - 28).

Biology

Life history: Oviposition occurred in marshy places protected from light such as thickets, water meadows and shaded gorges (Galuzo, 1941: 51 - 55). Under laboratory conditions the larvae fed and molted into nymphs on the host. Engorged nymphs were kept at 26 - 30° C. and the adults emerged 21 to 29 days later (Tzelishcheva, 1940: 31 - 35). Larvae and nymphs taken in the field between mid-June and mid-July were in a semi-starved state but those collected from August to October were fully fed (Grobov, 1946: 59 - 63). The engorged nymphs dropped from hares in the autumn and overwintered in grass meadows (Galuzo, 1941: 51 - 55; Grobov, 1946: 59 - 63). In the spring these nymphs molted into adults which attached to cattle, horses, sheep and man (Grobov, 1946: 59 - 63). Several gyandromorphs were found in Uzbek (Pavlovsky and Bernadskaya, 1948: 25 - 40). H. savignyi was found to be a two host tick (Pomerantzev and Matikashvili, 1940: 100 - 133).

Hosts of stages: Adult - man (Dojmi, 1939: 400 - 403; Grobov, 1946: 59 - 63; Chumakov, 1948: 268 - 271; Bilibin, 1950: 200 - 207; Viskovsky, 1951: 386 - 388; Gajdusek, 1953: 1 - 140), cattle (Pomerantzev and Matikashvili, 1940: 100 - 133; Zolotarev, 1934: 217 - 227; Lototzky and Popov, 1934: 67 - 80; Olenev, 1931: 249 - 261; Zasukhin, 1935: 1 - 159; Tzelishcheva, 1940: 31 - 35; Tzelishcheva, 1941: 63 - 64; Galuzo, 1944: 92 - 109; Olenev and Kastrov, 1932: 28 - 30; Olenev, 1931: 3 - 125; Pavlovsky and Bernadskaya, 1948: 25 - 40; Grobov, 1946: 59 - 63; Korshunova and Piontkovskaya, 1949: 186 - 187), zebu (Pomerantzev and Matikashvili, 1940: 100 - 133; Yakimov, et al., 1934: 235 - 254), buffalo (Pomerantzev and Matikashvili,

1940: 100 - 133; Lototzky and Popov, 1934: 67 - 80), horse (Pomerantzev and Matikashvili, 1940: 100 - 133; Zolotarev, 1934: 217 - 227; Olenev, 1931: 249 - 261; Galuzo, 1944: 92 - 109; Olenev and Kastrov, 1932: 28 - 30; Olenev, 1931: 3 - 125; Agriinsky, 1938: 1 - 9; Pavlovsky and Bernadskaya, 1948: 25 - 40; Markov, et al., 1940: 33; Kurchatov and Sokolov, 1940: 35; Grobov, 1946: 59 - 63), donkey (Pomerantzev and Matikashvili, 1940: 100 - 133), camel (Pomerantzev and Matikashvili, 1940: 100 - 133; Zolotarev, 1934: 217 - 227; Olenev, 1931: 249 - 261; Zasukhin, 1935: 1 - 159; Zasukhin, 1933: 31 - 46), sheep (Pomerantzev and Matikashvili, 1940: 100 - 133; Lagereva, 1946: 9 - 14; Zolotarev, 1934: 217 - 227; Lototzky and Popov, 1934: 67 - 80; Olenev, 1931: 249 - 261; Zasukhin, 1935: 1 - 159; Galuzo, 1944: 92 - 109; Olenev and Kastrov, 1932: 28 - 30; Olenev, 1931: 3 - 125; Grobov, 1946: 59 - 63), goat (Pomerantzev and Matikashvili, 1940: 100 - 133), dog (Pomerantzev and Matikashvili, 1940: 100 - 133), swine (Pomerantzev and Matikashvili, 1940: 100 - 133; Lototzky and Popov, 1934: 67 - 80; Olenev, 1931: 249 - 261), domestic animals (Galuzo, 1941: 51 - 55; Pavlovsky, 1945: 65 - 92; Kurchatov, 1940: 32; Pomerantzev, 1946: 1 - 28), birds (Pavlovsky, 1945: 65 - 92; Korshunova and Piontkovskaya, 1949: 186 - 187).

Nymph and Larva - Lepus europaeus transsylvanicus (Grobov, 1946: 59 - 63; Gajdusek, 1953: 1 - 140), hare (Korshunova and Piontkovskaya, 1949: 186 - 187), Grus grus, Melanocorypha calandra, Perdix perdix, domestic fowl, sparrow (Grobov, 1946: 59 - 63), Galerida cristata caucasica, Passer species, Upupa epops, Pica species (Pomerantzev and Matikashvili, 1940: 100 - 133).

Seasonal activity: In Crimea the adults were present on domestic animals from February to November and were most abundant in May, June (Kurchatov, 1940: 32) and July (Grobov, 1946: 59 - 63). This species constituted 87.4% of the ticks collected in September, 1944, in the Kerch Peninsula, but in November only single specimens could be found (Grobov, 1946: 59 - 63). In Transcaucasia the adults were active from March to November although single specimens could be found all winter; the larvae and nymphs were found on birds from June to November (Pomerantzev and Matikashvili, 1940: 100 - 133). In Tadzhik adults were found on cattle in the spring (Galuzo, 1935: 187 - 197). In the Lower Volga District and in western Kazakh the adults were active in June and August (Zasukhin, 1935: 1 - 159) and in Kazakh adults also occurred on cattle in the winter (Tzelishcheva, 1941: 63 - 64).

Habitats: All stages occurred in the forest zone, semi-steppe zone, shrub formations, mountain steppe zone (Pomerantzev and Matikashvili, 1940: 100 - 133), semi-desert zone (Pomerantzev and Mati-

kashvili, 1940: 100 - 133; Pomerantzev, 1934: 63 - 66; Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), mountain forest zone (Pomerantzev and Matikashvili, 1940: 100 - 133; Piontkovskaya, 1949: 419 - 420) and steppe zone (Piontkovskaya, 1949: 419 - 420). They were also found in stables in January (Demidov, et al., 1944: 22), on hard ground near hay ricks and straw stacks where hares sheltered in rainy weather, on waste land covered with grass and in places frequented by cattle (Grobov, 1946: 59 - 63).

Control Measures

Prophylaxis against Crimean Haemorrhagic Fever involved the protection of army personnel from tick bites by use of repellents, a special impregnation of uniforms and by systematic inspection. Ticks were controlled by cleaning camp sites, burning weeds and spraying tents (Chumakov, 1948: 268 - 271).

In laboratory tests promising results were obtained with pyrethrum powders having a pyrethrin content of 0.4 - 1% used either alone or mixed with talc or ash, with water suspensions of pyrethrum powder with or without the addition of kerosene and soap, with an emulsion prepared from a paste having a pyrethrin content of 0.06 - 0.1% and with ointments made from pyrethrum powder and vaseline or a similar substance. Though all preparations gave complete mortality of starved adults within periods ranging up to 13 days, a considerable percentage of engorged nymphs and adults survived. If they were feeding, however, the resistance of both nymphs and adult females was directly proportional to the degree to which they had engorged (Kurchatov, 1941: 97 - 103) and in other experiments pyrethrum had little effect on partly engorged females even after a second application (Blagoveshchensky and Serdyukova, 1946: 75 - 89). This species was also one of the more resistant tested. Pyrethrum powder was also found to prevent re-infestation by ticks as all adults died when placed on animals 2 - 48 hours after treatment. Larvae died when placed on treated animals within a fortnight (Kurchatov, 1941: 97 - 103).

Good control was given within 24 hours by dipping the animals in a 2% emulsion of creolin with the addition of 0.1 - 0.11% As_2O_3 as sodium arsenite (Lagereva, 1946: 9 - 14). Used lubricating oil, either alone or emulsified with clay or ox bile (3 1/2 parts oil and 5 parts clay or 4 parts oil and 4 parts ox bile to 10 parts water), gave good results. Though only a few were killed when infested parts on the body of the host were rubbed with oil the majority

dropped off and more ticks were killed on parts of the body covered with hair than on the hairless parts (Bernadskaya, 1944: 44).

When the dusts of 5% BHC were applied to adults in jars a high proportion of males and unfed females were killed and the rest were immobilized in 24 hours; partly engorged females were killed in 2 - 5 days and engorged females in 6 - 15 days. When adults were placed in jars on filter paper dusted with BHC or DDT the males and unfed females died in 48 hours, the partly engorged females in 4 - 8 days and the engorged females in 24 days. One engorged female exposed to BHC laid normal numbers of eggs six days after the beginning of the test and the resulting larvae were viable. Engorged females dusted with BHC, washed in plain water 24 hours later, allowed to dry and then placed in jars died 10 - 16 days later without ovipositing. Those dusted with DDT and similarly treated oviposited 5 days later and the larvae were viable. Eggs dusted with BHC and DDT did not hatch but those placed on dusted paper gave rise to viable larvae though hatching was delayed and reduced by BHC (Pavlov and Guorguiev, 1950: 107 - 118).

The burning of previous year's grass in pasture infested by this species gave good results (Agriinsky, 1941: 56 - 57).

Relation to Disease

Crimean Haemorrhagic Fever - H. savignyi was regarded as a vector of this disease (Grobov, 1946: 59 - 63; Bilibin, 1950: 200 - 207; Viskovsky, 1951: 386 - 388; Gajdusek, 1953: 1 - 140) which caused many fatal cases in the summer of 1944-45, particularly in several steppe districts in the west and in the Kerch Peninsula. The virus was isolated from unfed adults collected in the steppe and also from nymphs taken on horses, but it was not found in those taken on birds (Grobov, 1946: 59 - 63). The virus was preserved in ticks found naturally infected during the period between epidemics (Chumakov, 1948: 268 - 271). Lepus europaeus transsylvanicus was regarded as a reservoir for the disease agent and possibly other rodents were involved (Viskovsky, 1951: 386 - 388; Gajdusek, 1953: 1 - 140).

Relapsing Fever - Suspensions of adult ticks that had fed on guinea pigs artificially infected with a Stalinabad strain of relapsing fever were injected into healthy guinea pigs and it was shown that the ticks did not retain the spirochaetes for more than 24 hours after the infective feeding. The spirochaetes were not transferred to subsequent animals on which the adults completed their meal after having partly engorged on infected guinea pigs. It was shown by feed-

ing and by injection of suspensions of larvae and nymphs that the infection was not passed on to the progeny of females which had received an infective feeding. An emulsion prepared from eggs obtained from infected females and injected intraperitoneally into guinea pigs did not give rise to spirochaetes in the blood (Serdyukova, 1941: 135 - 144).

Brucellosis - The stomach contents of one of several females fed on guinea pigs infected with brucellosis revealed the presence of Brucella melitensis. Suspensions of small batches of ticks prepared immediately or 24 hours after engorgement were injected subcutaneously into 10 healthy guinea pigs and nine of these subsequently gave a positive reaction in serological tests. Cultures of the guinea pig organs showed the presence of B. melitensis in five of them. No serological reaction was obtained when suspensions of larvae of an experimentally infected female were injected into 2 healthy guinea pigs (Zotova and Balditzina, 1943: 48 - 49).

Rickettsiae - Ticks collected in the steppe zone of Crimea and others collected or reared from adults collected in the mountain forest zone produced fever in guinea pigs on which they fed. Autopsy of the guinea pigs revealed the presence of rickettsia-like organisms in the tunica vaginalis. The infection persisted in the ticks from stage to stage and from one generation to the next. Three strains of the infectious agent were isolated from guinea pigs. The infectious agent from the ticks was compared by cross-immunity tests with those of other rickettsiae occurring in the Soviet Union but the results were not conclusive (Kornshunova and Piontkovskaya, 1949: 186 - 187). Seven females which were the descendants of this original lot having been reared into the second and third generations showed upon examination polymorphic rickettsiae in the salivary glands, stomach, malpighian tubules or ovaries (Piontkovskaya, 1949: 419 - 420). In Uzbek organisms of the rickettsial type were observed in collections of larvae that were fed on rabbits and cattle. They were found in epithelium of the stomach and in other organs of the tick and they showed a great similarity to rickettsiae. The question of pathology remained unexplained for the ticks and for the domestic animals (Bernadskaya, 1943: 32).

Piroplasmosis - H. savignyi was found to be a natural and an experimental vector of Theileria annulata to cattle (Tzelishcheva, 1940: 31 - 35; Tzelishcheva, 1941: 63 - 64; Markov, et al., 1948: 13; Galuzo, 1943: 41 - 47). It was the only species found on cattle naturally infected with piroplasmosis in southern Kazakh. Laboratory reared larvae were fed on cattle heavily infected with T. annulata. These larvae molted to nymphs on the cattle and fed again. The resultant males and females transmitted T. annulata to cattle.

Larvae and nymphs that were offspring of females that had fed on cattle having an acute natural infection of T. annulata did not transmit the infection. T. mutans was experimentally transmitted to susceptible cattle by adults taken in an infected locality and by adults that had fed in the larval and nymphal stage on a bullock harboring parasites in its peripheral blood. Transmission was also affected by adults collected as nymphs from an infected cow (Tzelishcheva, 1940: 31 - 35).

This species also naturally and experimentally transmitted Nuttallia equi to horses (Markov, et al., 1940: 33; Agriinsky, 1938: 1 - 19).

Tick Paralysis, etc.: In experiments in Jugoslavia an extract was prepared from eggs and inoculated subcutaneously into the dorsal part of the neck of guinea pigs. This produced tick paralysis and the animals died in about six days (Mlinac and Oswald, 1936: 415 - 421).

A man bitten by this species in a village in Herzegovina exhibited acute but temporary poisoning as a result (Dojmi, 1939: 400 - 403).

Hyalomma schulzei Olenev

Hyalomma schulzei Olenev, 1931: 249 - 261; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Galuzo, 1935: 187 - 197; Delpy, 1937: 419 - 430; Pomerantzev, 1946: 23, 26; Pervomaisky, 1948: 35 - 40; Pomerantzev, 1950: 195 - 197.

Localities and Hosts

Iran - On camels (Delpy, 1937: 419 - 430; Pomerantzev, 1946: 23, 26); Teheran, Shakhrud, Neibandun, Seistan, Makhunik (Pomerantzev, 1950: 195 - 197; Olenev, 1931: 249 - 261); eastern Chorastan, Bandun, Semnan, Nischapur, on camels and cattle (Pomerantzev, 1950: 195 - 197); northern part (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139); eastern part (Olenev, 1931: 3 - 125). In northern and eastern Iran on boundary of U. S. S. R. (Olenev, 1931: 3 - 125) but not known in U. S. S. R. (Galuzo, 1935: 187 - 197; Pomerantzev, 1946: 23 - 26; Pomerantzev, 1950: 195 - 197).

Biology

Seasonal activity: Adults were found in January and May on camels. (Pomerantzev, 1950: 195 - 197).

Ixodes angustus Neumann

Ixodes angustus Neumann, 1899: 136; Neumann, 1911: 20; Serdyukova, 1941: 519 - 522; Serdyukova, 1948: 41 - 50; Pomerantzev, 1950: 80 - 83.

Localities and Hosts

U. S. S. R. - Konum on Southern Sakhalin Island and on the northern island of the Kuril group, off Sicista sp., Clethrionomys rufocanus and man (Pomerantzev, 1950: 80 - 83).

Biology

Life history: I. angustus showed an uninterrupted cycle (Pomerantzev, 1950: 80 - 83).

Hosts of stages: Adults on Sicista species, Clethrionomys rufocanus and man (Pomerantzev, 1950: 80 - 83).

Seasonal activity: This species was active the entire year (Pomerantzev, 1950: 80 - 83).

Ixodes apronophorus Schulze

Ixodes apronophorus Schulze, 1924: 281 - 284; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Golov, 1933: 32 - 38; Olenev, 1934: 672 - 674; Olenev, 1934: 367 - 388; Khatenever, 1942: 82 - 86; Karpov and Popov, 1944: 75 - 79; Pomerantzev, 1946: 7, 9, 10; Olsufiev, 1947: 291 - 292; Pavlovsky, 1948: 572 - 573; Pomerantzev, 1950: 63 - 68.

Ixodes arvicolae Warburton, 1926: 55 - 58; Olenev, 1931: 3 - 125.

Ixodes arvalis, Karpov and Popov, 1944: 75 - 79.

Localities and Hosts

Europe

Europe - western part (Pomerantzev, 1946: 7, 9, 10; Pomerantzev, 1950: 63 - 68). England - (Olenev, 1931: 126 - 139; Pomerantzev, 1950: 63 - 68). Germany - (Olenev, 1931: 126 - 139; Pomerantzev, 1950: 63 - 68).

U. S. S. R.

Karelo-Finnish S. S. R. - Karelian Isthmus; Baranov (Pomerantzev, 1950: 63 - 68). Kazakh S. S. R. - on water rat (Olenev, 1934: 367 - 388); eastern part (Pomerantzev, 1946: 7, 9, 10); Alma-Ata Province: vicinity of Alma-Ata (Pomerantzev, 1950: 63 - 68); on Arvicola terrestris and Microtus arvalis (Golov, 1933: 367 - 388).

R. S. F. S. R. - on water rats (Khatenever, 1942: 82 - 86); Archangel Province: southern shores of White Sea (Pomerantzev, 1946: 7, 9, 10; Pomerantzev, 1950: 63 - 68), on Arvicola scherman, Microtus oeconomus ratticeps (Olenev, 1931: 3 - 125); Maloshuika, on Microtus oeconomus ratticeps (Olenev, 1931: 126 - 139; Olenev, 1934: 672 - 674); Leningrad Province: southern part, in vicinity of Luga (Pomerantzev, 1950: 63 - 68); Novosibirsk Province: on small animals and birds (Karpov and Popov, 1944: 75 - 79); Sergino Village in Tschanov District, on water rat and Ondatra species (Olsufiev, 1947: 291 - 292). Western Siberia - (Pomerantzev, 1950: 63 - 68).

On following hosts without definite indication of locality: small rodents, water rat, Evotomys rufocanus (Pomerantzev, 1946: 7, 9, 10); Arvicola terrestris scherman, Arvicola terrestris, Microtus oeconomus ratticeps, Microtus arvalis, wood mouse, water pullet, and thrush (Pomerantzev, 1950: 63 - 68).

Biology

Life history: Oviposition occurred at a temperature of about 20° C. and lasted from 16 to 35 days. The eggs hatched in 20 to 39 days and continued to do so for 10 to 18 days. The larvae engorged in 2 1/2 to 8 days and the period of metamorphosis to the nymphal stage lasted from 24 to 218 days. Some larvae survived in the unfed condition for nearly a year. The nymphs required 3 to 8 days to engorge. Temperature had a decided effect upon the time required for metamorphosis to the adult stage and the time varied from 24 to 311

days. Nymphs were able to withstand starvation for over 400 days and most of them would attach only after a period of hibernation. The adults completed feeding in 5 1/2 to 7 days and some survived in the unfed state for over 400 days. Most of the adults would attach and feed only after a period of hibernation (Golov, 1933: 32 - 38). The cycle was completed in 2 or 3 years and a high degree of humidity was necessary (Golov, 1933: 32 - 38; Pomerantzev, 1950: 63 - 68).

Hosts of stages: Adult - Microtus oeconomus ratticeps (Olenev, 1931: 126 - 139; Olenev, 1934: 672 - 674; Pomerantzev, 1950: 63 - 68; Olenev, 1931: 3 - 125), Arvicola terrestris scherman (Olenev, 1931: 3 - 125; Pomerantzev, 1950: 63 - 68), water rat (Olenev, 1934: 367 - 388; Pomerantzev, 1946: 7, 9, 10; Khatenever, 1942: 82 - 86), Evotomys rufocanus (Pomerantzev, 1946: 7, 9, 10), Arvicola terrestris (Pomerantzev, 1950: 63 - 68; Golov, 1933: 32 - 38), wood mouse, water pullet, thrush (Pomerantzev, 1950: 63 - 68), birds (Pomerantzev, 1950: 63 - 68; Karpov and Popov, 1944: 75 - 79), small mammals (Karpov and Popov, 1944: 75 - 79).

Nymph - water rat (Pomerantzev, 1950: 63 - 68; Khatenever, 1942: 82 - 86; Olsufiev, 1947: 291 - 292), Microtus arvalis (Pomerantzev, 1950: 63 - 68; Golov, 1933: 32 - 38), Ondatra species (Olsufiev, 1947: 291 - 292), Arvicola terrestris (Golov, 1933: 32 - 38).

Larva - water rat (Pomerantzev, 1950: 63 - 68; Olsufiev, 1947: 291 - 292), Microtus arvalis (Pomerantzev, 1950: 63 - 68; Golov, 1933: 32 - 38), Ondatra species (Olsufiev, 1947: 291 - 292), Arvicola terrestris (Golov, 1933: 32 - 38).

Seasonal activity: Though single adults were recorded up to the end of October the maximum infestation on Arvicola was from April to June (Golov, 1933: 32 - 38; Pomerantzev, 1950: 63 - 68). The nymphs appeared in greatest numbers from March to July, though some were still found through November (Pomerantzev, 1950: 63 - 68). The larvae occurred in maximum numbers from March to the end of October and showed peaks of abundance in the Spring and the Fall (Golov, 1933: 32 - 38; Pomerantzev, 1950: 63 - 68).

Habitats: All stages were found in the forest zone consisting of northern firs and pines (Olenev, 1931: 3 - 125).

Relation to Disease

Ixodes apronophorus was important in the epidemiology of tularaemia since all stages occurring on water rats, especially nymphs and adults, were found to be infected with B. tularense (Golov, 1933:

32 - 38; Khatenever, 1942: 82 - 86; Pomerantzev, 1950: 63 - 68).

Ixodes arboricola bogatschevi Kirschenblatt

Ixodes arboricola bogatschevi Kirschenblatt, 1936: 93 - 97; Pomerantzev, 1950: 91.

This subspecies was described from two females collected August 28, 1933, on Sitta europaea caucasica in Transcaucasia.

Ixodes autumnalis Leach

Ixodes autumnalis Leach, 1815: 154 pp.; Olenev, 1929: 489 - 494; Olenev, 1930: 604 - 610; Tikhomirova and Nikanorov, 1930: 60 - 61; Karpov and Popov, 1944: 75 - 79).
Ixodes canisuga, Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314.

Nuttall and Warburton (1915) regarded this species as a synonym of Ixodes hexagonus. Olenev, in 1929, considered I. canisuga to be a synonym of I. autumnalis. Though it has been recorded in the U. S. S. R. by several authors, Pomerantzev (1950) did not include it in the fauna of the U. S. S. R.

Localities and Hosts

Kazakh S. S. R. - Alexander's Ridge, on Marmota caudata (Olenev, 1930: 604 - 610); northern side of Alexander's Ridge at head of Merke River, on Marmota species (Olenev, 1929: 489 - 494). Moldavian S. S. R. (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1929: 489 - 494). R. S. F. S. R. - Voronezh Province (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1929: 489 - 494). Ukrainian S. S. R. - Poltava Province: Cherkassy, on polecat (Olenev, 1929: 489 - 494). Altai Territory - in Old Devinsky Kaznets District (Olenev, 1929: 489 - 494). Khabarovsk Territory - on Marmota (Arctomys) bobak (Tikhomirova and Nikanorov, 1930: 60 - 61). Siberia - western part (Karpov and Popov, 1944: 75 - 79). On following hosts without definite indication of locality: badger and marmot (Olenev, 1928: 84 - 96).

Biology

Hosts of stages: Adult - polecat (Olenev, 1929: 489 - 494), badger, marmot (Olenev, 1928: 84 - 96). Nymphs - Marmota species (Olenev, 1929: 489 - 494).

Relation to Disease

Three specimens were found in Khabarovsk Territory July, 1929, on a dying tarabagan, Marmota (Arctomys) bobak, that had been artificially infected with plague in the laboratory. Bacillus pestis was found in cultures prepared from these ticks and also in the body of guinea pigs infected by injections of tick emulsion. Since the ticks preserved the bacillus longer than fleas and since they changed hosts readily it was thought that they might be of importance in the spread of the plague bacillus in nature (Tikhomirova and Nikanorov, 1930: 60 - 61).

Ixodes berlesei Birula

Ixodes berlesei Birula, 1895: 353 - 364; Nuemann, 1911: 27; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1929: 489 - 494; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Olenev, 1934: 367 - 388; Karpov and Popov, 1944: 75 - 79; Pomerantzev, 1946: 6, 8; Pomerantzev, 1950: 70 - 71.
Ixodes caledonicus Nuttall, 1910: 408 - 411.
Ixodes caledonicus sculpturatus Schulze, 1927/1929: 60 - 65.

This species was described from a single, engorged female collected in 1867. Nuttall and Warburton (1915) regarded it as a doubtful species, but Olenev (1929: 489 - 494) examined the type and regarded it as a valid species. The immature stages were not found.

Localities and Hosts

R. S. F. S. R. - Novosibirsk Province: on birds (Karpov and Popov, 1944: 75 - 79). Tadzhik S. S. R. - Gissar Valley (Pomerantzev, 1946: 6, 8; Pomerantzev, 1950: 70 - 71). Siberia - (Neumann, 1911: 27); central part (Olenev, 1931: 3 - 125); eastern part, near Angara

River (Birula, 1895: 353 - 364; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1929: 489 - 494; Olenev, 1929: 126 - 139; Olenev, 1931: 3 - 125; Olenev, 1934: 367 - 388; Pomerantzev, 1946: 6 - 8; Pomerantzev, 1950: 70 - 71). On following hosts without definite indication of locality: pigeons, starlings and other birds (Pomerantzev, 1946: 6 - 8); wild and domestic pigeons, Sturnus vulgaris, Falco caudicans, Monticola solitaria pandoo and Phoenicurus ochruros phoenicuroides (Pomerantzev, 1950: 70 - 71).

Biology

Habitat: Ixodes berlesei was endemic to the forest zone (Olenev, 1931: 126 - 139).

Relation to Disease

Though it occurred on birds in a tularaemic area in Novosibirsk it was doubted that I. berlesei had any importance in the spread of this disease (Karpov and Popov, 1944: 75 - 79).

Ixodes birulai Yakimov, Saikovich and Vasilevskaya

Ixodes birulai Yakimov, Saikovich and Vasilevskaya, 1926: 13 - 16; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139.

This species was described from a female taken in eastern European Russia without designation of host. Olenev (1931: 3 - 125) did not include it in a key to species of Ixodes and it was not included in the fauna of the U. S. S. R. by Pomerantzev (1950).

Localities

U. S. S. R. - In eastern European Russia (Yakimov, et al., 1926: 13 - 16). Bashkirskaya A. S. S. R. - Ufa Province (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139).

Ixodes canisuga Johnston

Ixodes canisuga Johnston, 1849: 371 ; Nuttall and Warburton, 1911: 209 - 214; Karpov and Popov, 1944: 75 - 79.

Olenev (1928: 84 - 96; 1929: 305 - 314) recorded specimens as Ixodes canisuga from Moldavian S. S. R. and Voronezh Province; however, he later (Olenev, 1929: 489 - 494) regarded these same specimens as I. autumnalis. Whether he regarded canisuga as a synonym of autumnalis or whether he corrected earlier errors in determination was not clear. Pomerantzev (1950) did not include either of these two species in the fauna of the U. S. S. R.

Localities and Hosts

R. S. F. S. R. - Novosibirsk Province: on small animals and birds (Karpov and Popov, 1944: 75 - 79).

Ixodes crenulatus Koch

Ixodes crenulatus Koch 1835 - 1844; Koch, 1844: 232; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Kirschenblatt, 1936: 93 - 97; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 1 - 28: Dubinin, 1948: 275 - 276; Pomerantzev, 1950: 89 - 91; Shatas, 1952: 802 - 818; Melnikova, 1953: 422 - 434.
Ixodes hexagonus, Olenev, 1931: 3 - 125, in part.

Localities and Hosts

Europe

Germany - (Olenev, 1931: 126 - 139).

Asia

Mongolia - on wild animals (Dubinin, 1948: 275 - 276).

U. S. S. R.

U. S. S. R. - southern part, on mammals (Pomerantzev, 1946: 1 -

28). Azerbaijan S. S. R. - Milskaya steppe, in burrows of Meles meles transcaucasicus (Kirschenblatt, 1936: 93 - 97). Georgian S. S. R. - vicinity of Tibilisi, on hedgehog (Pomerantzev and Matikashvili, 1940: 100 - 133). Kirghiz S. S. R. - Tian Shan Province (Pomerantzev, 1950: 89 - 91). Moldavian S. S. R. - (Olenev, 1931: 3 - 125; Pomerantzev, 1950: 89 - 91).

R. S. F. S. R. - Chita Province: in Dauriya Steppe, on wild animals (Dubinin, 1948: 275 - 276); Astrakhan Province (Shatas, 1952: 802 - 818); Stalingrad Province: ranges from Kolatschov District and Verkhne-Kurmoyarsk District in the north to Liman and south to Astrakhan Province, on foxes and wolves (Shatas, 1952: 802 - 818).

Tadzhik S. S. R. - (Pomerantzev, 1950: 89 - 91). Ukrainian S. S. R. - (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139); Transcarpathian Province (Pomerantzev, 1950: 89 - 91).

Crimean A. S. S. S. - in Simferopol part of Crimean State Forest Reservation, mainly in Chyr-Alan and Kosa, on dogs and in dens of foxes and Meles meles (Melnikova, 1953: 422 - 434). Transbaikalia - (Pomerantzev, 1950: 89 - 91). Transcaucasia - (Pomerantzev, 1950: 89 - 91).

On following hosts without definite indication of locality: dogs, hedgehogs, various rodents (Olenev, 1931: 3 - 125), fox, badger, jackal (Pomerantzev, 1950: 89 - 91).

Biology

Life history: Little information was available regarding the life cycle of this species. The cycle probably continued without interruption throughout the year. Males were seldom found on the host and from its weak chitinization and absence of dark pigmentation on its outer surface it was thought to lead a sheltered life (Shatas, 1952: 802 - 818).

Hosts of stages: The main hosts were carnivores and all stages occurred on hosts in great numbers ranging from tens to hundreds (Shatas, 1952: 802 - 818).

Seasonal activity: Specimens were collected in May in Azerbaijan (Kirschenblatt, 1935: 93 - 97). In Stalingrad and Astrakhan Provinces they were found almost the entire year, though no data were available for January, February and March (Shatas, 1952: 802 - 818). In Crimea, the adults were active April, May, June, August, and September and the nymphs were active March, April, May, August and September (Melnikova, 1953: 422 - 434).

Habitats: All stages were found in steppe zones (Olenev, 1931:

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3 - 125), in xerophyllous steppes (Dubinin, 1948: 275 - 276) and from the lowlands to the mountain peaks of Transcaucasia (Pomerantzev, 1950: 89 - 91).

Relation to Disease

This species was regarded as a carrier of plague and haemosporidians of dogs in the U. S. S. R. and it caused paralysis of sheep in western Europe (Pomerantzev, 1950: 89 - 91).

Ixodes frontalis (Panzer)

Acarus frontalis Panzer, 1798: t. 23.
Ixodes frontalis, Koch, 1844: 234; Koch 1847: 23; Schulze and Schlottke 1929: 106; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Kirschenblatt, 1936: 93 - 97; Oswald, 1938: 54 - 61; Pomerantzev and Matikashvili, 1940: 100 - 133; Karpov and Popov, 1944: 75 - 79; Pomerantzev, 1946: 9; Pomerantzev, 1950: 68 - 70; Melnikova, 1953: 422 - 434.
Ixodes apronatus Kirschenblatt, 1934: 257 - 261; Pomerantzev and Matikashvili, 1940: 100 - 133).
Ixodes brunneus Koch, 1844: 232; Schulze, 1930: 106; Olenev, 1931: 3 - 125.

Localities and Hosts

Europe

Europe - (Olenev, 1931: 126 - 139); western part, on birds (Pomerantzev, 1946: 9; Pomerantzev, 1950: 68 - 70). England, Germany, France, Italy, on birds (Pomerantzev, 1950: 68 - 70). Jugoslavia, in Vardar Province of southern Serbia, on birds (Oswald, 1938: 54 - 61).

U. S. S. R.

Ukrainian S. S. R. - Poltava Province, on various wild birds (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139). R. S. F. S. R. - Novosibirsk, on birds (Karpov and Popov, 1944: 75 - 79). Crimean A. S. S. R. on Garrulus iphigenia and Merula merula aterima (Melni-

kova, 1953: 422 - 434). Transcaucasia - on birds (Pomerantzev, 1946: 9); eastern and western parts, on Chloris chloris, Fringilla montifringilla, Turdus merula and Regulus regulus (Pomerantzev, 1950: 68 - 70). Georgian S. S. R. - Lagodekhi (Pomerantzev and Matikashvili, 1940: 100 - 133), on Fringilla montifringilla (Kirschenblatt, 1936: 93 - 97); Kutaisi (Pomerantzev and Matikashvili, 1940: 100 - 133).

On following hosts without definite indication of locality: Chloris chloris, Fringilla montifringilla (Pomerantzev and Matikashvili, 1940: 100 - 133); mountain finch, thrush, etc. (Pomerantzev, 1946: 9).

Biology

Life history: Only the female was found (Kirschenblatt, 1936: 93 - 97).

Seasonal activity: Females were found in February, March and May in Transcaucasia (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 68 - 70).

Habitats: The female was found in the steppe zone of Poltava (Olenev, 1931: 3 - 125).

Ixodes kazakstani Olenev and Sorokoumov

Ixodes kazakstani Olenev and Sorokoumov, 1934: 73 - 74; Olenev, 1934: 367 - 388; Pomerantzev, 1946: 7, 11; Pomerantzev, 1950: 51 - 52.

Localities and Hosts

Kazakh S. S. R. - in Dzharkent, female, on clothing of man, 20-VI-1932 (Olenev and Sorokoumov, 1934: 73 - 74; Olenev, 1934: 367 - 388; Pomerantzev, 1950: 51 - 52); Kirghiz S. S. R. - in Dmitrovka on Talas River, male, on pheasant, 29-VIII-1915 (Pomerantzev, 1950: 51 - 52).

Ixodes laguri laguri Olenev

Ixodes redikorzevi lagurae Olenev, 1929: 489 - 494; Zasukhin and Tif-

lov, 1933: 437 - 442.

Ixodes redikorzevi laguri, Olenev, 1930: 604 - 610; Olenev, 1931: 3 - 125.

Ixodes laguri, Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Kolpakova and Lippert, 1932: 191 - 195; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Kirschenblatt, 1936: 93 - 97, in part.

Ixodes laguri laguri, Pomerantzev, 1946: 7, 9; Pomerantzev, 1950: 52 - 56; Shatas, 1952: 802 - 818.

Localities and Hosts

Azerbaijan S. S. R. - Beliasuwar, in nest of Meriones bogdanovi (Kirschenblatt, 1936: 93 - 97).

Kazakh S. S. R. - northwestern part (Kirschenblatt, 1936: 93 - 97), on Lagurus lagurus (Olenev, 1930: 604 - 610; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139), from steppes of southern Volga (north of Old Bukelvsky Orda) to the north from Novaya Kazanka, on Lagurus lagurus (Olenev, 1929: 489 - 494); western part (Pomerantzev, 1946: 7, 9), in nests of Citellus species (Kolpakova and Lippert, 1932: 191 - 195); Talov, Ural, Slomikhin and Kalmykov Districts (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 54 - 56).

R. S. F. S. R. - southeastern part, on Citellus pygmaeus (Zasukhin and Tiflov, 1933: 434 - 442); Stalingrad Province: on marmots and in their burrows, Putorius eversmanni, Microtus arvalis, fox, Hemiechinus species, wood mouse, house mouse, cat, water rats (Shatas, 1952: 802 - 818); Lower Volga Region: (Kirschenblatt, 1936: 93 - 97; Pomerantzev, 1946: 7, 9); Ilovlinsk Station in Stepnov District (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 54 - 56); Lower Don Region (Pomerantzev, 1950: 54 - 56); Kalmoblast; Elistinsk District (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159).

Ukrainian S. S. R. - southern part (Pomerantzev, 1946: 7, 9); Axania Nova (Pomerantzev, 1950: 54 - 56).

Daghestan A. S. S. R. - (Pomerantzev, 1946: 7, 9; Pomerantzev, 1950: 54 - 56).

On following hosts without definite indication of locality: Lagurus lagurus (Zasukhin, 1935: 1 - 159; Zasukhin, 1933: 31 - 46; Kirschenblatt, 1936: 93 - 97), Cricetus cricetus (Zasukhin, 1935: 1 - 159; Zasukhin, 1933: 31 - 46; Kirschenblatt, 1936: 93 - 97), Citellus pygmaeus (Zasukhin, 1935: 1 - 159; Zasukhin, 1933: 31 - 46; Kirschenblatt, 1936: 93 - 97), Microtus arvalis (Zasukhin, 1935: 1 - 159), in burrows of rodents (Kirschenblatt, 1936: 93 - 97; Pomerantzev, 1946: 7, 9), lemmings, hamsters, marmots (Pomerantzev, 1946: 7, 9), common

hamster, gray hamster, gray field-mouse, wood mouse, eared hedgehog, common hedgehog, small Siberian marmot, pole cat and weasel (Pomerantzev, 1950: 54 - 56).

Biology

Life history: The average duration of the life cycle was 132 days (Pomerantzev, 1950: 54 - 56).

Hosts of stages: The males were not found on the hosts.

Seasonal activity: This species was active in Stalingrad and Astrakhan Provinces from March to November with the maximum activity in April, May and June (Shatas, 1952: 802 - 818).

Habitat: This species was found in the steppes of the southern Volga Region to the north from Novaya Kazanka (Olenev, 1929: 489 - 494); in the desert zone of northwestern Kazakh (Olenev, 1931: 126 - 139); in the northern and southern parts of the semi-desert zone (southeastern corner of Lower Volga Region and Western Kazakh) (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159) and it was adapted to existence in the semi-desert regions of Stalingrad and Astrakhan Provinces (Shatas, 1952: 802 - 818).

Relation to Disease

This species occurred on ground squirrels which were known plague reservoirs in the southeastern part of the R. S. F. S. R. (Zasukhin and Tiflov, 1933: 437 - 442). It was regarded as a vector of tularemia in Astrakhan and Stalingrad Provinces (Shatas, 1952: 802 - 818) and in Kazakh S. S. R., Lower Volga Region, Southern Ukrainian S. S. R., Lower Don, and Daghestan A. S. S. R. (Pomerantzev, 1950: 54 - 56).

Ixodes laguri armeniacus Pomerantzev and Kirschenblatt

Ixodes laguri armeniacus Pomerantzev, 1946: 7, 9, nomen nudum; Pomerantzev, 1948: 39 - 46, validates nomen nudum; Pomerantzev, 1950: 56 - 58.

Ixodes laguri, Kirschenblatt, 1936: 93 - 97, in part.

Localities and Hosts

Armenian S. S. R. - Nalbaud, Talysch, Zuvant, on Mesocricetus brandti (Pomerantzev, 1948: 39 - 46; Kirschenblatt, 1936: 93 - 97); Nalbaud and Achtinsk Province and Talysch, on Mesocricetus auratus and Microtus arvalis (Pomerantzev, 1950: 56 - 58).

Biology

Seasonal activity: This sub-species was found in May and August-September (Pomerantzev, 1948: 39 - 46; Pomerantzev, 1950: 56 - 58).

Habitat: The females were found in the mountain steppes of the Armenian volcanic belt and the males were found only in the holes or in the burrows of the hosts (Pomerantzev, 1948: 39 - 46; Pomerantzev, 1950: 56 - 58).

Ixodes laguri colchicus Pomerantzev

Ixodes laguri colchicus Pomerantzev, 1946: 7, 11, nomen nudum; Pomerantzev, 1948: 39 - 46, validates nomen nudum; Pomerantzev, 1950: 58 - 60.

Localities and Hosts

Western Caucasia - in vicinity of Babuk-Aul of the Adler district, on Glis glis (Pomerantzev, 1948: 39 - 46; Pomerantzev, 1950: 58 - 60).

Biology

Seasonal activity: It was active in September (Pomerantzev, 1948: 39 - 46; Pomerantzev, 1950: 58 - 60).

Habitat: This subspecies was found in the forest region of Western Caucasia (Pomerantzev, 1948: 39 - 46; Pomerantzev, 1950: 58 - 60).

Ixodes occultus Pomerantzev

Ixodes occultus Pomerantzev, 1946: 7, nomen nudum; Pomerantzev, 1948: 39 - 46; validates nomen nudum; Pomerantzev, 1950: 60.

Only the male of this species was found and it was apparently the first Ixodes reported from the deserts of Turkmenia. The description was based upon specimens taken on Rhombomys opimus in Repetek, Turkmen S. S. R. The type was deposited in the Zoological Institute of the Academy of Science, U. S. S. R. (Pomerantzev, 1948: 39 - 46; Pomerantzev, 1950: 60).

Ixodes ovatus Neumann

Ixodes ovatus Neumann, 1899: 116 - 117; Neumann, 1911: 18, in part; Shpringgoltz-Shmidt, 1935: 137 - 186.
Ixodes ricinus var. ovatus, Olenev, 1928: 84 - 96; Olenev, 1929: 489 - 494; Olenev, 1929: 305 - 314.

Olenev, (1929: 489 - 494) stated that I. ricinus var. ovatus described by Neumann from Japan should be regarded as an independent species. Pomerantzev (1950: 44) did not include this species in the fauna of the U. S. S. R. and stated that it occurred in Japan.

Localities and Hosts

Caucasia - (Neumann, 1899: 116 - 117). Khabarovsk Territory - (Shpringgoltz-Shmidt, 1935: 137 - 186). Siberia - Amur Region - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314); near Lake Benzia, Ussuri District of Karsky, southwestern Azbaikal (Olenev, 1929: 489 - 494). Japan - on Equus caballus L., Canis familiaris L., and Lepus species (Neumann, 1911: 18).

Ixodes pavlovskyi Pomerantzev

Ixodes pavlovskyi Pomerantzev, 1946: 11, nomen nudum; Pomerantzev, 1948: 39 - 46, validates nomen nudum; Pomerantzev and Serdyukova, 1948: 47 - 67; Pomerantzev, 1950: 49 - 51.

Only the female of this species was found. Though the description was given in 1948, references to its occurrence in the fauna of the Russian Far East were made earlier (Pomerantzev and Serdyukova, 1940: 336 - 337 and Pavlovsky, 1947: 160 - 201) and the description in 1948 validates a nomen nudum. The type was deposited in the Zoological Institute, Academy of Science, U. S. S. R.

Localities and Hosts

Iman Forests in Primor Territory, on wood hen (Pomerantzev, 1948: 39 - 46; Pomerantzev, 1950: 49 - 51).

Ixodes persulcatus Schulze

Ixodes persulcatus Schulze, 1930: 294 - 303; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Hoeppli and Feng, 1933: 29 - 43; Olenev, 1934: 672 - 674; Olenev, 1934: 367 - 388; Olenev, 1934: 672 - 674; Kochetkov, 1935: 124 - 127; Schulze, 1936: 526; Soloviev, 1938: 484 - 492; Mironov, 1938: 415 - 434; Mironov, 1939: 123 - 136; Zilber, 1939: 9 - 37; Shubladze and Serdyukova, 1939: 121 - 131; Gutsevich and Skrynnik, 1939: 161 - 177; Pavlovsky, 1939: 94 - 95; Alfeev, 1940: 23 - 25; Pomerantzev and Serdyukova, 1940: 336 - 337; Pisyaukova, 1940: 18 - 19; Khodakovsky, 1940: 20 - 21; Moskvin, 1940: 12 - 13; Serdyukova and Khodakovsky, 1940: 17; Blagoveshchensky, 1940: 15 - 17; Levkovich and Skrynnik, 1940: 118 - 121; Pavlovsky, 1940: 58 - 71; Pavlovsky and Soloviev, 1940: 111 - 117; Smorodintsev, 1940: 468 - 480; Chumakov, et al., 1940: 86 - 91; Chumakov and Zeitlenok, 1940: 263 - 264; Mironov, 1940: 93 - 105; Sudachenkov, 1941: 41 - 44; Olenev, 1941: 39 - 40; Sudachenkov, 1941: 25 - 27; Chumakov, 1941: 65 - 67; Kozlova and Grachev, 1941: 17 - 19; Folitarek, 1941: 15 - 16; Zhmaeva, 1941: 14; Galuzo, 1941: 51 - 55; Skrynnik and Ryzhov, 1941: 41 - 49; Ryzhov and Skrynnik, 1941: 27 - 33; Pervomaisky, 1941: 81 - 94; Levkovich and Skrynnik, 1941: 19 - 22; Soloviev, 1941: 95 - 111; Ryzhov and Kozlova, 1941: 34 - 40; Pisyaukova, 1941: 65 - 80; Mironov, 1941: 427 - 433; Khatenever, 1942: 82 - 86; Volodina, 1942: 179 - 186; Mironov and Baldina, 1942: 51 - 53; Krontovskaya and Shmatikov, 1943: 65 - 68; Pshenichnov and Khramushin, 1943: 78 - 79; Gruzdeva, 1943: 102 - 104; Gruzdeva, 1943: 51 - 53; Pervomaisky, 1943: 211 - 213; Levkovich, 1943: 49 - 53;

Shkorbatov, 1944: 43 - 46; Soliterman, 1944: 50; Karpov and Popov, 1944: 75 - 79; Chumakov, et al., 1944: 83 - 89; Casals and Webster, 1944: 45 - 63; Pavlovsky, 1945: 65 - 92; Chumakov, et al., 1945: 18 - 24; Marikovsky, 1945: 60 - 66; Nelzina, 1945: 55 - 60; Kalabukhov and Shubladze, 1946: 68 - 75; Serdyukova, 1946: 60 - 63; Pomerantzev, 1946: 8, 11; Pavlovsky, 1947: 160 - 201; Pavlovsky, 1947: 265 - 285; Pletzity, 1947: 46 - 51; Pletzity, 1947: 877 - 878; Perovmaisky, 1947: 75 - 78; Pomerantzev and Serdyukova, 1948: 47 - 67; Pomerantzev, 1948: 20 - 24; Dubinin, 1948: 275 - 276; Serdyukova, 1948: 41 - 50; Khodakovsky, 1948: 69 - 82; Pavlovsky, 1948: 572; Blagoveshchensky, 1948: 115 - 124; Blagoveshchensky, 1948: 83 - 113; Pomerantzev, 1950: 43 - 49; Olenev, 1950: 149 - 151; Nikolskaya, 1950: 272 - 274; Kheisin, 1950: 572 - 574.

Ixodes persulcatus cornuatus Olenev, 1941: 39 - 40.

Ixodes persulcatus diversipalpis Schulze, 1930: 294 - 301.

Localities and Hosts

Europe

Germany - in northern parts (Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 43 - 49).

Asia

China - (probably this species, Hoeppli and Feng, 1933: 29 - 43).

U. S. S. R.

Karelo-Finnish S. S. R. - (Chumakov, 1941: 65 - 67; Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 43 - 49); in southwestern and in southern parts (Chumakov, et al., 1944: 83 - 89); Karel Promontory (Khodakovsky, 1948: 69 - 82); in southern regions Petrov, Zaonezh, Kondopoga, Pudozh, Pryazha, and Olonets (Olenev, 1934: 672 - 674); in Danilovo village of Medvezhegorsky district, on cattle (Olenev, 1934: 367 - 388); in Logmarutschie, Lekh-novolok, Schuia of Prionezhsky district, on cattle; Petrov district, on cattle; in Tschebino, Pinduschi, Povenets of Medvezhegorsky district, on cattle; in Evgora, Karelskaya, Maselga of Segozersky district, on cattle; in Pogost and Podany, northwest of Lake Segozero, on cattle (Kheisen, 1950: 572 - 574).

Kazakh S. S. R. - on domestic and wild animals (Galuzo, 1941: 51 - 55). Kirghiz S. S. R. - Tian - Shan Mountains (Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 43 - 49).

R. S. F. S. R. - (Olenev, 1934: 367 - 388); in western part (Chumakov, et al., 1944: 83 - 89); in northwestern part (Olenev, 1934: 672 - 674); Chita Province: in Dauriya Steppes, on wild rodents, birds and man (Dubinin, 1948: 275 - 276); Chkalov Province: in Middle Volga Region (Folitarek, 1941: 15 - 16); Irkutsk Province (Olenev, 1934: 672 - 674); Kalinin Province (Chumakov, et al., 1944: 83 - 89; Pomerantzev, 1946: 8, 11); Kamchatka Province (Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 43 - 49); Kemerovo Province (Pletzity, 1947: 46 - 51; Pletzity, 1947: 877 - 878); Kuibuishev Province: in Middle Volga Region (Folitarek, 1941: 15 - 16); in Schentalinsk district (Chumakov, et al., 1944: 83 - 89); Leningrad Province: (Alfeev, 1940: 23 - 25; Chumakov, et al., 1944: 83 - 89; Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 43 - 49); in southeastern part in Kirillovski, Myaksa, Moshenskaya, Belozersk, Efimovski, Babayevko, Kaiduiski and Prishehsnivshi of Cherepovets and Borovichi districts on cattle; in northwestern part in Oraniyenbaum, Volosovo, Krasnogvordeiski, in southwestern part in Starya Russia and Demianovski (Olenev, 1934: 672 - 674); in White Lake Region in eastern part of province, on cattle and small mammals (Khodakovsky, 1940: 20); in western and southwestern districts, between Gulf of Finland and Lakes Ladoga, Ilmen and Peipus, on cattle; in eastern and southeastern districts, on cattle; in northeastern districts adjoining Lakes Ladoga and Onega, on cattle (Sudachenkov, 1941: 41 - 44); in eastern part, on cattle (Olenev, 1941: 39 - 40; Sudachenkov, 1941: 25 - 27); in eastern parts and also in small areas in the western part (Khodakovsky, 1948: 69 - 82); Molotov Province (Pshenichnov and Khramushin, 1943: 78; Chumakov, et al., 1944: 83 - 89); Novosibirsk Province (Olenev, 1934: 672 - 674); Orel Province (Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 43 - 49); Perm Province: (Olenev, 1934: 672 - 674); in Middle Kama Region, on cows, goats, dogs and various small mammals and birds (Mironov, 1940: 93 - 105); in Ural Mountains (Folitarek, 1941: 15 - 16); Sakhalin Province (Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 43 - 49); Smolensk Province (Chumakov, et al., 1944: 83 - 89); Omsk Province: in Tobolsk (Olenev, 1934: 672 - 674); Tomsk Province (Olenev, 1934: 672 - 674); Velikiye Luki Province: in Velidovo District, on cattle and man (Kalabukhov and Shubladze, 1946: 68 - 75); Vladimir Province (Olenev, 1934: 672 - 674); Vologda Province: in Belozersky, Ustinzhensky, Tschagodoshensky, Tscherepovetsky, Babaeyvsky, Miaksinsky, on cattle; in Belozersky district, on Turdus musicus, Lyrurus tetrix, Asio flammeus, Emberiza

citrinella, Emberiza schoeniclus, Penthestes atricapillus borealis, Corvus cornix cornix, Anthus trivalis, Sorex araneus, Evotomys glareolus; on dogs, sheep, horses (Khodakovsky, 1948: 69 - 82).

Siberia - central part (Soliterman, 1944: 50), on cattle, horses, dogs and cats (Krontovskaya and Shmatikov, 1943: 65 - 68); in eastern part (Chumakov, et al., 1944: 83 - 89); in western part (Chumakov, et al., 1944: 83 - 89; Khodakovsky, 1948: 69 - 82), on domestic animals and rodents (Karpov and Popov, 1944: 75 - 79).

Transural Region - (Kochetkov, 1935: 124 - 127). Ural Regions - Pshenichnov and Khramushin, 1943: 78 - 79), on man (Chumakov, et al., 1940: 86 - 91). Ural and Priural Regions (Chumakov, et al., 1944: 83 - 89). Trans-Baikal Region (Olenev, 1934: 672 - 674).

Primor territory - (Olenev, 1934: 672 - 674; Zhmaeva, 1941: 14; Gruzdeva, 1943: 102 - 104; Nikolskaya, 1950: 272 - 274); southern part (Marikovsky, 1945: 60 - 66); coastal region of Tigrovsk Lumber Industry Collective, on domestic animals and man (Nelzina, 1945: 55 - 60); Barabash Region (Pavlovsky, 1947: 265 - 285); Suputin Reservation (Pomerantzev and Serdyukova, 1948: 47 - 67), on various animals and birds (Pervomaisky, 1947: 75 - 78), man (Pomerantzev and Serdyukova, 1940: 336 - 337); Ussuri Province (Mironov, 1940: 93 - 105) birds (Moskvin, 1940: 12 - 13; Kozlova and Grachev, 1941: 17 - 19), small mammals (Kozlova and Grachev, 1941: 17 - 19), man (Pervomaisky, 1941: 81 - 94); near Lake Khanka (Mironov, 1938: 415 - 434); southern part, on Eutamias and Sciurus (Ryzhov and Kozlova, 1941: 34 - 40); along Suputinka River and in Krivoi Klutch (Soloviev, 1941: 95 - 111).

Khabarovsk Territory - (Olenev, 1931: 126 - 139; Soloviev, 1938: 484 - 492; Zilber, 1939: 9 - 37; Levkovich and Skrynnik, 1940: 118 - 121; Pavlovsky and Soloviev, 1940: 111 - 117; Chumakov and Zeitlenok, 1940: 263 - 264; Levkovich and Skrynnik, 1941: 19 - 22; Shkorbatov, 1944: 43 - 46; Chumakov, et al., 1944: 83 - 89; Pavlovsky, 1945: 65 - 92; Pavlovsky, 1947: 160 - 201), on birds (Pavlovsky, 1940: 58 - 71; Ryzhov and Skrynnik, 1941: 27 - 33; Pervomaisky, 1943: 211 - 213), cattle, horses, dogs, clothing of man (Skrynnik and Ryzhov, 1941: 41 - 49), domestic animals, rodents, Eutamias sibiricus, Sciurus vulgaris, Turdus hortulorum (Ryzhov and Skrynnik, 1941: 27 - 33), wild animals (Gruzdeva, 1943: 51 - 53), small mammals (Pervomaisky, 1943: 211 - 213); Amur Region (Olenev, 1931: 3 - 125; Olenev, 1934: 672 - 674; Pisyaukova, 1941: 65 - 80), on deer (Khodakovsky, 1948: 69 - 82); Lower Amur Region, on domestic animals, large wild mammals, rodents, Sorex species and birds (Blagoveshchensky, 1940: 15 - 17); near Lower Tambovsk, 50° 55' north latitude, on Sciurus vulgaris (Blagoveshchensky, 1948: 115 - 124); along Lower Tambovsk in Komsomolsk district and Khabarovsk district, on cattle, horses, swine, dogs, cats, sheep, goats,

Cervus canadensis xanthopygaeus, Alces alces americanus n. bedfordi, Moschus moschiferus parvipes, Sikka (Pseudaxis) hortulorum, Vulpes vulpes, Canis lupus, Nyctereutes procyonoides, Tigris tigris amurensis, Sciurus vulgaris, Eutamias asiaticus orientalis, Rattus norvegicus caraco, Apodemus speciosus praetor, Evotomys rufocanus, Sorex species, Cervus corone orientalis, Garrulus glandarius brandtii, Cractes infaustus maritimus, Coccothraustes coccothraustes japonicus, Uragus sibiricus ussuriensis, Passer montanus, Emberiza aureola ornata, Emberiza spodocephala extremi-orientis, Alauda arvensis, Anthus hodgsoni, Sitta europaea amurensis, Muscicopa davurica, Phylloscopus fuscatus, Locustella lanceolata, Phragmaticola aëdon rufescens, Turdus pallidus, Calliope calliope, Tetrastes bonasia, Capella megala (Blagoveshchensky, 1948: 83 - 113).

Krasnoyarsk Territory - in Yeniseysk (Olenev, 1934: 672 - 674); in northern Sayan Mountains in the southern part of Ermak region of Minusinsk District (Pisyaukova, 1940: 18 - 19); on northern slopes of western Sayan Mountains in the southern part of the territory (Serdyukova and Khodakovsky, 1940: 17); in western Sayan Mountains and in the flat parts of this region (Khodakovsky, 1948: 69 - 82).

Altai Territory (Olenev, 1934: 672 - 674). Western Territory, in Kholmski, Penovski, Toropetzki and Velikolutzki (Olenev, 1934: 672 - 674). Northern Territory, on cattle (Olenev, 1934: 672 - 674).

Bashkirskaya A. S. S. R. - (Khodakovsky, 1948: 69 - 82). Tatarskaya A. S. S. R. - in middle Volga Region (Politarek, 1941: 15 - 16). Kurile Islands (Pomerantzev, 1950: 43 - 49).

On following hosts without definite indication of locality - cattle, horse, sheep, dog, rabbit, lynx (Olenev, 1934: 672 - 674); on wild and domestic ungulates, man, small mammals and birds (Pomerantzev, 1946: 8, 11); domestic animals, wild ungulates, deer, elk, rodents, insectivores, carnivores, birds, Amur hedgehog, dormouse, hare, woodhen, man (Pomerantzev, 1950: 43 - 49).

Biology

Life history: Oviposition occurred 5 to 14 days after the female dropped from the host (Khodakovsky, 1940: 20 - 21; Gruzdeva, 1948: 69 - 82; Gruzdeva, 1943: 51 - 53). Only females weighing at least 90 mg. oviposited and those weighing 250 mg. laid approximately 3000 eggs (Olenev, 1941: 39 - 40). The eggs were laid in the surface cover of the taiga (Pomerantzev and Serdyukova, 1940: 336 - 337). The eggs were the least resistant of the overwintering stages and those that were not killed when the temperature went below -7 to -8° C. were

apparently destroyed in the spring by predators (Sudachenkov, 1941: 41 - 44; Pshenichnov and Khramushin, 1943: 78 - 79). The eggs hatched in 43 to 66 days coinciding with the warmest part of the year and when rain was abundant (Khodakovsky, 1940: 20 - 21; Gruzdeva, 1943: 51 - 53). The duration of development of eggs kept in test-tubes at a relative humidity of 100% was inversely related to the temperature within the limits of 5 and 30° C. and though most of the eggs did not survive at 65% humidity some hatching occurred (Olenev, 1941: 39 - 40).

The larvae hatched in 32 to 34 days (Olenev, 1941: 39 - 40) and crawled up plants growing in the taiga to await their hosts (Pomerantzev and Serdyukova, 1940: 336 - 337). They readily attached to hedgehogs and completed their feeding in 3 to 6 days (Olenev, 1941: 39 - 40). The larvae molted to the nymphal stage in about 30 to 36 days after feeding (Olenev, 1941: 39 - 40; Gruzdeva, 1943: 51 - 53). Unfed larvae survived the winter if the temperature did not go below -7 to -8° C. (Sudachenkov, 1941: 41 - 44).

The nymphs molted into adults in 27 to 69 days after feeding (Gruzdeva, 1943: 51 - 53; Olenev, 1941: 39 - 40). Unfed nymphs survived the winter if the temperature did not go below -30° C. (Sudachenkov, 1941: 41 - 44; Pshenichnov and Khramushin, 1943: 78 - 79).

The females required 4 to 12 days to complete engorgement on cattle (Olenev, 1941: 39 - 40). Unfed adults survived the winter if the temperature did not go below -30° C. (Sudachenkov, 1941: 41 - 44; Pshenichnov and Khramushin, 1943: 78 - 79) but engorged females could not overwinter (Sudachenkov, 1941: 41 - 44). Unfed females were kept alive for about one month but partially engorged ones survived for over 100 days. Both unfed and engorged females copulated (Olenev, 1941: 39 - 40).

The length of time required to complete the cycle was determined by the climate and this time varied from 2 to 3 years (Pomerantzev, 1950: 43 - 49; Serdyukova and Khodakovsky, 1940: 17).

Hosts of stages: Adult - cattle (Mironov, 1940: 93 - 105; Khodakovsky, 1940: 20 - 21; Krontovskaya and Shmatikov, 1943: 65 - 68; Khodakovsky, 1948: 69 - 82; Blagoveshchensky, 1948: 83 - 133), goats (Mironov, 1940: 93 - 105; Blagoveshchensky 1948: 83 - 113), dogs (Mironov, 1940: 93 - 105; Krontovskaya and Shmatikov, 1943: 65 - 68; Blagoveshchensky, 1948: 83 - 113), domestic animals (Blagoveshchensky, 1940: 15 - 17; Galuzo, 1941: 51 - 55; Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 43 - 49), large wild mammals (Blagoveshchensky, 1940: 15 - 17; Pomerantzev, 1946: 8, 11; Khodakovsky, 1948: 69 - 82; Pomerantzev, 1950: 43 - 49; Blagoveshchensky, 1948: 83 - 113), horses (Krontovskaya and Shmatikov, 1943: 65 - 68; Blagoveshchensky, 1948:

83 - 113), cats (Krontovskaya and Shmatikov, 1943: 65 - 68; Blagoveshchensky, 1948: 83 - 113), swine, sheep (Blagoveshchensky, 1948: 83 - 113), hedgehogs, hares, carnivores (Khodakovsky, 1948: 69 - 82), man (Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 43 - 49), deer, elk (Pomerantzev, 1950: 43 - 49).

Nymph - cattle (Mironov, 1940: 93 - 105; Blagoveshchensky, 1948: 83 - 113), goats, dogs (Mironov, 1940: 93 - 105), passerine birds (Pavlovsky, 1940: 58 - 71), Eutamais sibiricus, Sciurus vulgaris (Ryzhov and Kozlova, 1941: 34 - 40; Ryzhov and Skrynnik, 1941: 27 - 33), Amur hedgehog, dormouse, hare, wood hen (Pomerantzev, 1950: 43 - 49), man (Pomerantzev, 1950: 43 - 49), horses (Blagoveshchensky, 1948: 83 - 113), Turdus hortulorum (Ryzhov and Skrynnik, 1941: 27 - 33).

Nymph and larva - small mammals (Mironov, 1940: 93 - 105; Chumakov, et al., 1940: 86 - 91; Khodakovsky, 1940: 20 - 21; Galuzo, 1941: 51 - 55; Pomerantzev, 1946: 8, 11; Khodakovsky, 1948: 69 - 82; Pomerantzev, 1950: 43 - 49), birds (Mironov, 1940: 93 - 105; Chumakov, et al., 1940: 86 - 91; Blagoveshchensky, 1940: 15 - 17; Moskvin, 1940: 12 - 13; Pavlovsky, 1947: 265 - 285; Pomerantzev, 1946: 8, 11; Khodakovsky, 1948: 69 - 82; Pomerantzev, 1950: 43 - 49; Blagoveshchensky, 1948: 83 - 113), squirrels (Chumakov, et al., 1940: 86 - 91; Blagoveshchensky, 1948: 83 - 113), hares, chipmunks (Chumakov, et al., 1940: 86 - 91), Eutamias asiaticus orientalis (Blagoveshchensky, 1948: 83 - 113), rodents (Blagoveshchensky, 1948: 83 - 113; Blagoveshchensky, 1940: 15 - 17; Pomerantzev, 1950: 43 - 49), insectivores, carnivores (Pomerantzev, 1950: 43 - 49), shrews (Blagoveshchensky, 1940: 15 - 17), raven, magpie, hazel-hen, yellow hammer, ouzel, starling, nightingale, sparrow (Pavlovsky, 1947: 265 - 285).

Larva - wood hen, small rodents (Pomerantzev, 1950: 43 - 49).

Seasonal activity: It was essentially the same in all areas of U. S. S. R. with the greatest activity of all stages occurring in the first half of the warm period of the year. As the autumn season approached the larvae and nymphs increased slightly in numbers on the host while the adults were almost completely absent from the end of summer to the beginning of winter. In the colder regions of the taiga only one stage developed in one warm season with both the larvae and nymphs undergoing a diapause in the winter. In the 3 year cycle the adults attacked in masses at the end of May and at the beginning of June, whereas, from August on they did not attack as a rule (Pomerantzev, 1950: 43 - 47).

In Leningrad Province they occurred on cattle in the eastern part from early May until mid-July when they disappeared (Olenev, 1941: 39 - 40). In the White Lake Region the adults were abundant on cattle at the end of May and at the beginning of June and they disappeared at the

end of July. The larvae and nymphs which occurred on small mammals were found chiefly in the spring and in the first half of summer (Khodakovsky, 1940: 20 - 21).

In Primor Territory the curve of infestation of domestic animals along the coastal region was single peaked with the maximum abundance in May. From the end of June to September activity gradually diminished and it ended in the first ten days of October (Nelzina, 1945: 55 - 60). In other parts the greatest activity occurred in the second half of May and in July. In the zone of deciduous forests with a mixture of cedar, the activity decreased in July while at the same time in the higher situated forests and near the tributaries of the Suputinka River, great quantities were observed in both June and July (Pomerantzev and Serdyukova, 1940: 336 - 337). In Ussuri Province they were most active in mid-April and in mid-June (Mironov, 1938: 415 - 438).

In Khabarovsk Territory along the Lower Tambovsk in Komsomolsk District the adults were found on cattle only in limited quantities; the larvae and nymphs were found simultaneously on their hosts from the beginning of July (Blagoveshchensky, 1948: 83 - 113).

All stages were found on the northern slopes of the western Sayan Mountains in Krasnoyarsk Territory during July-August (Serdyukova and Khodakovsky, 1940: 17).

In the Ural Region the immature stages were abundant in August and in September on small mammals and birds (Chumakov, et al., 1940: 86 - 91) and in the Trans-Ural Region uninterrupted activity of all stages occurred from spring to the end of summer (Kochetkov, 1935: 124 - 127).

In the taiga belt of the European part of the U. S. S. R. the adults were observed in maximum numbers in May and in the beginning of June (Khodakovsky, 1948: 69 - 82).

In the Prionezhsky District of Karelo-Finnish S. S. R. the maximum infestation occurred at the end of May and in the beginning of June. The infestation decreased sharply in the first half of July, and in the second half of July only single individuals were found, whereas, in August and in September none were found. In the Petrov District there was a 100% infestation of cattle in May and in June (Kheisin, 1950: 572 - 574).

Habitats: The usual habitat of all stages was the forest zone (Mironov, 1940: 93 - 105; Blagoveshchensky, 1940: 15 - 17; Serdyukova and Khodakovsky, 1940: 17; Khodakovsky, 1940: 20 - 21; Pisyaukova, 1940: 18 - 19; Mironov, 1938: 415 - 434; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Politarek, 1941: 15 - 16; Krontovskaya and Shmatikov, 1943: 65 - 68; Pisyaukova, 1941: 65 - 80; Karpov and Popov,

1944: 75 - 79; Pletzity, 1947: 46 - 51; Pletzity, 1947: 877 - 878; Dubinin, 1948: 275 - 276; Pomerantzev and Serdyukova, 1948: 47 - 67; Khodakovsky, 1948: 69 - 82; Kheisin, 1950: 572 - 574; Olenev, 1934: 672 - 674; Blagoveshchensky, 1948: 83 - 113). They also occurred in small numbers in natural pastures (Olenev, 1941: 39 - 40) but they gradually disappeared from areas where clearing had been made and which were exposed to the drying action of the sun (Mironov, 1940: 93 - 105). None were found in water meadows, in a willow plantation or in an aspen forest with an undergrowth of fern (Blagoveshchensky, 1940: 15 - 17). In the mountains all stages were abundant in mixed forests at an altitude of 1300 - 1500 feet. However, they were scarce in coniferous forests at altitudes of 2300 - 2600 feet and were practically absent at altitudes of 4600 feet (Serdyukova and Kohdakovsky, 1940: 17). The ticks were numerous in partly cleared portions of the forest, considerably less so in the more cultivated parts and were absent from the undisturbed primeval forest (Khodakovsky, 1940: 20 - 21). This species apparently does not penetrate far into the steppe region (Karpov and Popov, 1944: 75 - 79; Pletzity, 1947: 46 - 51; Pletzity, 1947: 877 - 878) and only a few were found in the steppe zone (Dubinin, 1948: 275 - 276).

Habits: When ticks were released they promptly crawled away and traveled extensively until a suitable place to await a host was found. They preferred footpaths of the woods (Marikovsky, 1945: 60 - 66) and were more common on tracks made by man or animals than on either side of these tracks (Pavlovsky, 1940: 56 - 71). Some crawled under the surface layer of litter and moved only at the onset of nightfall. The rate of progression was dependent upon temperature, degree of stimulation and the microrelief; the average rate of progression along footpaths was 4.2 - 15 meters per hour and along footpaths in the woods it was 1.8 - 6 meters per hour (Marikovsky, 1945: 60 - 66). As a rule the attacking ticks sat on the tips of twisting or overhanging shrubs (Pomerantzev and Serdyukova, 1940: 336 - 337). In the early spring a very delicate twig of the underbrush was selected on which to await a host and at the end of the spring and in the summer a more protruding part of the foliage of shrubs and weeds was used. Quite often the ends of fine twigs of Lespedeza bicolor were covered with ticks. In addition, preference was shown for twigs overhanging free areas at the periphery of groups of shrubs, and along the footpaths of woods (Marikovsky, 1945: 60 - 66). In addition to passive waiting an active inquiry for scented prey was shown as well as the more rare descent of ticks from above to transient animals (Pomerantzev and Serdyukova, 1940: 336 - 337; Marikovsky, 1945: 60 - 66). More ticks attached to persons walking slowly than

to those walking rapidly (Pavlovsky, 1940: 58 - 71). They attacked man 24 hours a day (Pomerantzev and Serdyukova, 1940: 336 - 337) but they only attached to cattle during the night (Serdyukova, 1946: 73 - 74). During heavy rains a marked decrease of attacking ticks was observed (Pomerantzev and Serdyukova, 1940: 336 - 337).

Tick parasites: Hunterellus hookeri (Blagoveshchensky, 1940: 15 - 17; Pervomaisky, 1947: 75 - 78; Alfeev, 1940: 23 - 25; Pervomaisky, 1943: 211 - 213; Blagoveshchensky, 1948: 115 - 124; Pomerantzev, 1950: 43 - 49) and Ixodiphagus hirtus were found parasitizing various stages of Ixodes persulcatus (Nikolskaya, 1950: 272 - 274; Pomerantzev, 1950: 43 - 49).

Control Measures

Short term measures included such practices as the examination of the body and clothes for the presence of ticks (Mironov, 1941: 427 - 433; Mironov, 1938: 415 - 434; Pervomaisky, 1941: 81 - 94); the use of overalls closely fitting at the neck and wrists and provided with a hood covering the ears and lower part of the chin (Pervomaisky, 1941: 81 - 94; Mironov, 1938: 415 - 434; Mironov, 1941: 427 - 433); ordinary clothes, when made to fit tightly at the neck, wrists and waist and worn with top boots (Pervomaisky, 1941: 81 - 94); and the impregnation of clothes with repellents (Mironov, 1941: 427 - 433; Pervomaisky, 1941: 81 - 94). Various compounds were tested for repellent action (10% lysol; 5% turpentine in water; 1 - 1.5% of preparation K, dixanthogen, emulsified in water by soap; and 1.5% solution of polychlorides, mixture of chlor- and dichlorbenzines) and these were found to give little protection though they did slow up the crawling of the ticks. A higher concentration of preparation K gave better results. A 5% lysol and 2% phenol spray remained effective for only ten days on large plots under natural conditions in the forest but sprays were suggested for treating smaller areas (Pervomaisky, 1941: 81 - 94).

Long term measures involved the elimination of ticks by rendering the ecological conditions unsuitable for them. These included treatment of infested cattle and other domestic animals (Pervomaisky, 1941: 81 - 94; Mironov, 1938: 415 - 434; Krontovskaya and Shmatikov, 1943: 65 - 68; Mironov, 1941: 427 - 433); the destruction of hares, birds, and other wild animals serving as host for larvae and nymphs (Mironov, 1941: 427 - 433; Folitarek, 1941: 15 - 16; Krontovskaya and Shmatikov, 1943: 65 - 68); the destruction of cover in pastures and forests by burning, mowing or clearing to reduce the humidity and

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to increase fluctuations in temperature (Mironov, 1941: 427 - 433; Mironov, 1938: 415 - 434; Politarek, 1941: 15 - 16; Krontovskaya and Shmatikov, 1943: 65 - 68); pasture rotation (Khodakovsky, 1940: 20 - 21; Khodakovsky, 1948: 69 - 82); grazing of cattle in the spring on cultivated and isolated pastures (Khodakovsky, 1948: 69 - 82; Politarek, 1941: 15 - 16); the use of anti-tick control measures along paths most often used by humans (Pomerantzev and Serdyukova, 1940: 336 - 337); and the avoidance of dangerous parts of the forest between mid-April and mid-June when the ticks were most active (Mironov, 1938: 415 - 434). Since the intensive reproduction of this species in the little inhabited places of the taiga was the result of extensive use of pasture type farming, it was necessary to apply the above mentioned measures at the earlier stages of colonization of the taiga landscape (Khodakovsky, 1948: 69 - 82).

Relation to Disease

Piroplasmosis - Adults were found to transmit Babesia bovis experimentally (Pomerantzev, 1950: 43 - 49; Sudachevkov, 1941: 25 - 27), but nymphs from larvae which had received an infecting feed did not transmit it, nor did the resulting adults (Sudachevkov, 1941: 25 - 27).

Tularemia - Spontaneous infection was demonstrated in specimens collected from cattle in two areas where tularemia was endemic (Karpov and Popov, 1944: 75 - 79; Khatenever, 1942: 82 - 86).

Bite reaction - Cases were reported where the bites of I. persulcatus in June and early July followed by engorging for up to 5 hours produced papules which disappeared after a time. However, most of them reappeared after one and a half months and 3 appeared a third time after 6 months. This would indicate that the substances introduced by the tick into the skin persist at the site of the bite after external symptoms have disappeared. A case occurred in which irritation and papules were produced by the bites of several ticks, probably this species, and an ulcer developed at the site of the bite which did not heal for 8 months (Mironov and Baldina, 1942: 51 - 53).

Spring-Summer Encephalitis - I. persulcatus transmitted the virus causing this disease in man and animals (Chumakov and Zeitlenok, 1940: 263 - 264; Chumakov, et al., 1940: 86 - 91; Smorodintzev, 1940: 468 - 480; Pavlovsky and Soloviev, 1940: 111 - 117; Pavlovsky, 1940: 58 - 71; Levkovich and Skrynnik, 1940: 118 - 121; Moskvin, 1940: 12 - 13; Shubladze and Serdyukova, 1939: 121 - 131; Zilber, 1939: 9 - 37; Soloviev, 1938: 484 - 492; Politarek, 1941: 15 - 16;

Ryzhov and Skrynnik, 1941: 27 - 33; Levkovich and Skrynnik, 1941: 19 - 22; Soloviev, 1941: 95 - 111; Ryzhov and Kozlova, 1941: 34 - 40; Levkovich, 1943: 49 - 53; Chumakov, et al., 1944: 83 - 89; Casals and Webster, 1944: 45 - 63; Pavlovsky, 1945: 65 - 92; Nelzina, 1945: 55 - 60; Kalabukhov and Shubladze, 1946: 68 - 75; Pavlovsky, 1947: 160 - 201; Chumakov, et al., 1945: 18 - 24; Pomerantzev, 1950: 43 - 49).

Spontaneous infection of I. persulcatus was first found by Ryzhov and Skrynnik and experimental transmission was proven by Chumakov. Soloviev discovered the reservoir to be various taiga animals, such as field mice and hedgehogs, while Moskvin found the virus to be present in taiga birds (Chumakov, et al., 1944: 83 - 89). The virus of spring-summer encephalitis was normally transmitted to man only by I. persulcatus and I. ricinus but it could be transmitted by other ixodids that attack man fairly frequently (Chumakov, et al., 1945: 18 - 24). The tick vectors in order of importance were Ixodes persulcatus, Haemaphysalis concinna and Dermacentor silvarum (Pavlovsky, 1945: 65 - 92). Within the epidemiological areas I. persulcatus was the dominant tick in numbers and in activity and its seasonal period was longer than that of the other species (Levkovich, 1943: 49 - 53).

A comparison of three strains of Russian spring-summer encephalitis with louping ill which was transmitted in Britain by I. ricinus showed that the two viruses were closely related but possibly were not identical (Casals and Webster, 1944: 45 - 63).

Spring-summer encephalitis was reported from the Far East (Chumakov, et al., 1944: 83 - 89; Kalabukhov and Shubladze, 1946: 68 - 75). Priural Regions, eastern and western Siberia, Karelia (Chumakov, et al., 1944: 83 - 89), Ural Regions (Chumakov, et al., 1940: 86 - 91; Chumakov, et al., 1944: 83 - 89), Cis-Ural Regions, Volga Regions (Kalabukhov and Shubladze, 1946: 68 - 75), Kuibuishev Province (Folitarek, 1941: 15 - 16; Chumakov, et al., 1944: 83 - 89) and adjacents parts of Chkalov Province and Tatar A. S. S. R. (Folitarek, 1941: 15 - 16), Kalinin Province, Smolensk Province (Chumakov, et al., 1944: 83 - 89), Leningrad Province (Chumakov, et al., 1944: 83 - 89; Kalabukhov and Shubladze, 1946: 68 - 75), Velikye Luki Province, Vologda Province (Kalabukhov and Shubladze, 1946: 68 - 75), Primor Territory (Mironov, 1938: 415 - 434; Soloviev, 1941: 95 - 111; Ryzhov and Kozlova, 1941: 34 - 40; Nelzina, 1945: 55 - 60; Mironov, 1940: 93 - 105), in basin of Middle Kama of Perm Province(Mironov, 1940: 93 - 105), Khabarovsk Territory (Pavlovsky and Soloviev, 1940: 111 - 117; Pavlovsky, 1940: 58 - 71; Levkovich and Skrynnik, 1940: 118 - 121; Moskvin, 1940: 12 - 13; Shubladze and Serdyukova, 1939: 121 -

131; Zilber, 1939: 9 - 37; Soloviev, 1938: 484 - 492; Ryzhov and Skrynnik, 1941: 27 - 33; Levkovich and Skrynnik, 1941: 19 - 22).

To some extent endemic zones were in forest localities (Chumakov and Zeitlenok, 1940: 263 - 264; Chumakov, et al., 1940: 86 - 91; Ryzhov and Skrynnik, 1941: 27 - 33; Levkovich and Skrynnik, 1940: 118 - 121; Zilber, 1939: 9 - 37; Ryzhov and Kozlova, 1941: 34 - 40) but sporadic cases and localized outbreaks occurred in several parts of the U. S. S. R., including European districts, which were not in the forest zone (Chumakov and Zeitlenok, 1940: 263 - 264). Natural foci of spring-summer encephalitis were associated with plateau and water-sheds where ravines and lime trees were abundant and where high rainfall occurred. The forests in the ravines provided favorable conditions for the ticks and their hosts and this was the only type of habitat in which naturally infected Ixodes persulcatus and Apodemus flavicollis were found (Politarek, 1941: 15 - 16).

The disease affected people engaged in forest work and it appeared in people who had been attacked 1 - 2 weeks previously by I. persulcatus (Chumakov and Zeitlenok, 1940: 263 - 264). The incidence of spring-summer encephalitis was directly related to exposure to ticks (Smorodintsev, 1940: 468 - 480).

Ticks were found naturally infected at all stages of development (Chumakov and Zeitlenok, 1940: 263 - 264; Levkovich and Skrynnik, 1940: 108 - 121; Smorodintsev, 1940: 468 - 480). Unfed adults collected in nature and fed on laboratory animals passed the virus through the egg and through the subsequent stages (Chumakov and Zeitlenok, 1940: 263 - 264; Smorodintsev, 1940: 468 - 480). Starved females rapidly acquired the virus from artificially infected mice and the virus, which penetrated into all their internal organs in five days, remained active. The virulence, as shown by titration, remained unchanged in the intestine for 25 days. The concentration of the virus in the genitalia first decreased but it regained its original level after 25 days (Pavlovsky and Soloviev, 1940: 111 - 117). The virus apparently multiplied in the ticks without harming them (Chumakov and Zeitlenok, 1940: 263 - 264). The virus in the salivary glands and in the brain was found to be highly toxic. Virus was also present in the intestine, Malpighian tubules, and genitalia and it did not lose any of its properties in these organs (Pavlovsky and Soloviev, 1940: 111 - 117).

Only Ixodes persulcatus was able to take up the minimum quantities of the virus which were far below the lethal dose for mice and to pass it on to its offspring. The virus lived and multiplied only in this species and it was found to die off quickly within 10 - 30

days in other species (Levkovich, 1943: 49 - 53).

Naturally infected ticks were abundant in the first half of summer but the virus could not be detected in those collected in the second half of July or in August. The virus was probably rendered temporarily inactive by some environmental factor, for it presumably persisted and overwintered in the ticks since the first cases of encephalitis in the spring occurred in April about the time the unfed adults appeared in the field (Pavlovsky, 1940: 58 - 71).

Erinaceus amurensis, Eutamias sibericus, Sciurus vulgaris, Evotomys rufocanus and other rodents were found naturally infected and were known hosts of Ixodes persulcatus (Pavlovsky, 1940: 58 - 71; Smorodintsev, 1940: 468 - 480; Soloviev, 1938: 484 - 492; Chumakov and Zeitlenok, 1940: 263 - 264; Ryzhov and Skrynnik, 1941: 27 - 33). Birds were also found to be naturally infected and immature ticks of this species were taken on a number of them (Moskvin, 1940: 12 - 13). Of various bird species infected in the laboratory, the infection was apparent in some and latent in others (Pavlovsky, 1940: 58 - 71). Domestic animals probably helped spread the infection because infected ticks were found on them (Soloviev, 1938: 484 - 492). Observations suggest that rodents, unlike ticks, cannot serve as reservoirs of the virus for any considerable period (Chumakov, et al., 1940: 26 - 91).

Transmission to man and to animals was affected through the saliva and transmission to eggs was due to the penetration of the virus through the wall of the ovary (Pavlovsky and Soloviev, 1940: 111 - 117). Experiments showed a lasting transmission of virus through the cycle-infected tick-mouse-tick even when the blood of the host contained a relatively insignificant quantity of the virus (Levkovich, 1943: 49 - 53). The degree of success of the transmission of the virus by ticks depended on the length of time they (in groups of 10 - 20 per mouse) were left on the host. It was found that two days of continued feeding was the minimum time for successful transmission (Shubladze and Serdyukova, 1939: 121 - 131).

It was concluded from studies that a latent immunization of the population took place irrespective of their contact with cases of encephalitis and that it was acquired in the forest through the bites of naturally infected ticks. The role of ticks in this immunization was confirmed by experiments carried out with females that had fed on mice artificially infected with a human strain of virus. The ticks were allowed to feed on healthy mice and these mice were tested for resistance by injecting them with 2, 5 or 25 minimum lethal doses of the virus. Some of the mice proved to be resistant

even when the highest dosage was given and it was found that their blood contained antibodies which rendered the virus inactive. The degree of immunity varied with the number of ticks used per mouse and with the duration of their feeding (Levkovich and Skrynnik, 1941: 19 - 22). Protective antibodies were present in the sera from horses, cattle (Smorodintsev, 1940: 468 - 480; Soloviev, 1938: 484 - 492; Soloviev, 1941: 95 - 111), man (Smorodintsev, 1940: 468 - 480; Soloviev, 1941: 95 - 111), and rodents (Smorodintsev, 1940: 468 - 480) and the sera of all animals trapped in an endemic area showed a high content of anti-bodies (Soloviev, 1941: 95 - 111). The absence of the disease in areas where the virus occurred in animals was probably due to the existence of natural immunity in the local population (Kalabukhov and Shubladze, 1946: 68 - 75).

Ixodes plumbeus Leach

Ixodes plumbeus Leach, 1814: 396; Pomerantzev, 1950: 91.

Localities and Hosts

Kazakh S. S. R. - Guryev Province: in nest of swallow in vicinity of Guryev (Pomerantzev, 1950: 91).

Ixodes pomerantzevi Serdyukova

Ixodes pomerantzevi Serdyukova, 1941: 519 - 522; Pomerantzev, 1946: 9, 10; Pavlovsky, 1947: 160 - 201; Pomerantzev, 1950: 78 - 80.

Only the female and the nymph of this species were described.

The type was deposited in the Zoological Institute of the Academy of Science, U. S. S. R.

Localities and Hosts

Primor Territory - (Pavlovsky, 1947: 160 - 201; Ussuri Forest of Voroshilov District on Evotomys rufocanus, Eutamias asiaticus, and Erinaceus amurensis (Serdyukova, 1941: 519 - 522); Suputin Reser-

vation, on Clethrionomys rufocanus, Eutamias asiaticus, Erinaceus amurensis and Sorex sp. (Pomerantzev, 1950: 78 - 80).

Ixodes redikorzevi redikorzevi Olenev

Ixodes redikorzevi Olenev, 1927: 219 - 224; Olenev, 1928: 84 - 96; Olenev, 1929: 489 - 494; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Zasukhin, 1931: 135 - 156; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 7, 11; Melnikova, 1953: 422 - 434.
Ixodes redikorzevi redikorzevi, Pomerantzev, 1950: 422 - 434.
Ixodes theodori Warburton, 1927: 405 ; Olenev, 1929: 489 - 494; Olenev, 1931: 3 - 125.
Ixodes transcaucasicus Kirschenblatt, 1934: 257 - 261; Kirschenblatt, 1936: 93 - 97; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 61.
Ixodes diversicoxalis Kirschenblatt, 1936: 267 - 268; Kirschenblatt, 1936: 93 - 97; Pomerantzev and Matikashvili, 1940: 100 - 133.

Localities and Hosts

R. S. F. S. R. - southeastern part, on Citellus pygmaeus (Zasukhin, 1931: 135 - 156). Crimean A. S. S. R. (Olenev, 1927: 219 - 224; Olenev, 1928: 84 - 96; Olenev, 1929: 489 - 494; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 7, 11); Baidar (Pomerantzev, 1950: 62 - 63); Crimean State Forest, on Apodemus sylvaticus, hare and lizard (Melnikova, 1953: 422 - 434). Transcaucasia (Pomerantzev, 1946: 7, 11; Pomerantzev, 1950: 62 - 63). Georgian S. S. R. - vicinity of Kutaisi, on Erinaceus ponticus (Pomerantzev and Matikashvili, 1940: 100 - 133); in vicinity of Tibilisi, in nest of Microtus socialis satunini (Kirschenblatt, 1936: 267 - 268; Kirschenblatt, 1936: 93 - 97; Pomerantzev and Matikashvili, 1940: 100 - 133). Tadzhik S. S. R. (Pomerantzev, 1946: 7, 11; Pomerantzev, 1950: 62 - 63). Azerbaijan S. S. R. - Beliasuwar, on Vormela sarmatica and Hemiechinus calligoni brachyotis (Kirschenblatt, 1934: 257 - 261; Kirschenblatt, 1936: 93 - 97; Pomerantzev and Matikashvili, 1940: 100 - 133).

On following hosts without definite indication of locality - hedgehogs, Evotomys rufocanus, mice, thrush and other birds (Pomerantzev, 1946: 7, 11), Erinaceus ponticus, Hemiechinus calligoni brachy-

otis, Vormela sarmatica, Microtus socialis satunini, Nesokia indica huttoni, Apodemus sylvaticus, Phylloscopus collybitus, Saxicolla torquata, Oenanthe opistholeuca, Turdus atrogularis, Galerida cristata, Ophisaurus apodus.

Biology

Hosts of stages: No definite information was available for immature stages.

Seasonal activity: The adults were active in October, December, April and May; the larvae and nymphs were found in April, June and August (Pomerantzev, 1950: 62 - 63).

Habitat: All stages were found in the forest zone (Olenev, 1931: 3 - 125).

Ixodes redikorzevi emberizae Pomerantzev

Ixodes redikorzevi emberizae Pomerantzev, 1950: 63.

Localities and Hosts

Azerbaijan S. S. R. - Lenkoran, on Emberiza schoeniclus (Pomerantzev, 1950: 63). Tadzhik S. S. R. - In Gissar Mountains on Emberiza schoeniclus (Pomerantzev, 1950: 63).

Biology

Hosts of stages: Adults and nymphs were found on Emberiza schoeniclus (Pomerantzev, 1950: 63).

Seasonal activity: The females were recorded in February and the nymphs and larvae were found in December, January and June (Pomerantzev, 1950: 63).

Ixodes ricinus (Linnaeus)

Acarus ricinus Linnaeus, 1758: 616.

Ixodes ricinus, Nuttall and Warburton, 1911: 143 - 156, 294 - 315; Neumann, 1911: 12 - 13; Marzinovsky, 1914: 714 - 735; Markov, 1916: 313 - 335; Knuth, et al., 1918: 241 - 264; Kotlán, 1919: 34 - 35; Kotlán, 1921: 43 - 50; Yakimov, 1922: 41 - 46; Yakimov and Vasilevskaya, 1924: 52 - 64; Olenev, 1924: 36 - 41; Yakimov, et al., 1926: 13 - 16; Zakhorov, 1926: 53 - 59; Pavlovsky, 1926: 14 pp.; Yakimov, et al., 1926: 224 - 258; Yakimov and Vasilevskaya, 1926: 192 - 210; Olenev, 1926: 15 - 17; Pavlovsky and Shtein, 1927: 574 - 586; Olenev, 1927: 354 - 368; Popov, 1928: 15 - 18; Pavlovsky, 1928: 368 - 376; Olenev, 1928: 84 - 96; Olenev and Pomerantzev, 1928: 376 - 385; Olenev, 1929: 489 - 494; Olenev, 1929: 305 - 314; Olenev, 1929: 25 pp.; Elmanov, 1930: 466 - 472; Pomerantzev and Blagoveshchensky, 1930: 401 - 420; Blagoveshchensky and Pomerantzev, 1930: 695 - 703; Olenev, 1930: 604 - 610; Olenev, 1931: 126 - 139; Olenev, 1931: 281 - 284; Olenev, 1931: 3 - 125; Pavlovsky, et al., 1932: 207 - 216; Olenev and Kastrov, 1932: 28 - 30; Zasukhin, 1933: 31 - 46; Lototzky and Popov, 1934: 67; Yakimov, et al., 1934: 235 - 254; Zolotarev, 1934: 217 - 227; Olenev, 1934: 367 - 388; Kurchatov and Kalmikov, 1934: 80 pp.; Olenev, 1934: 672 - 674; Galuzo, et al., 1935: 167 - 185; Shpringgoltz—Shmidt, 1935: 137 - 186; Alfeev, 1935: 111 - 136; Pomerantzev, 1935: 32 - 111; Zasukhin, 1935: 1 - 159; Pavlovsky, 1935: 22 - 31; Kochetkov, 1935: 124 - 127; Zasukhin, 1936: 457 - 460; Zasukhin, 1936: 461 - 470; Mlinac and Oswald, 1936: 415 - 421; Kirschenblatt, 1936: 93 - 97; Yakimov and Mizkevitsch, 1936: 161 - 162; Pomerantzev and Alfeev, 1936: 187 - 194; Zasukhin, et al., 1936: 148 - 154; Zasukhin, 1936: 155 - 164; Zasukhin, 1936: 219 - 226; Cernaianu, 1937: 281 - 293; Alfeev, 1939: 99 - 109; Shcheglova, 1939: 83 - 101; Oswald, 1939: 305 - 306; Kurchatov, 1940: 32; Kurchatov and Sokolov, 1940: 35; Mironov, et al., 1940: 106 - 108; Pomerantzev and Matikashvili, 1940: 100 - 133; Mironov, 1940: 409 - 410; Alfeev, 1940: 23 - 25; Chumakov, 1941: 65 - 67; Olsufiev, 1941: 436 - 439; Olenev, 1941: 1 p.; Sudachenkov, 1941: 41 - 44; Sudachenkov, 1941: 25 - 27; Olenev, 1941: 39 - 40; Chizh, 1941: 58 - 60; Petrov, 1941: 29 - 31; Naidenova, 1941: 20 - 31; Khatenever, 1942: 82 - 86; Casals and Webster, 1944: 45 - 63; Chumakov, et al., 1944: 83 - 89; Karpov and Popov, 1944: 75 - 79; Chumakov and Naidenova, 1944: 89 - 93; Demidov, et al., 1944: 22; Chumakov, et al., 1945: 18 - 24; Cherkassky, 1945: 24 - 27; Zilber, 1945: 45 - 48; Pavlovsky, 1945: 65 - 92; Pomerantzev, 1946: 8, 11; Kalabukhov and Shubladze, 1946: 68 - 75;

Olsufiev, 1947: 255 - 262; Alfeev, 1947: 11 - 12; Pavlovsky, 1948: 570 - 572; Kohdakovsky, 1948: 69 - 82; Kolachev and Kosovsky, 1949: 42 - 48; Olenev, 1950: 149 - 151; Pomerantzev, 1950: 37 - 43; Olenev, 1950: 1119 - 1120; Kheisin, 1950: 572 - 574; Gajdusek, 1953: 1 - 140; Melnikova, 1953: 422 - 434; Kuznetsov, 1953: 441 - 443; Kratokhvil, 1954: 61 - 63.

Ixodes areololaris Olenev, 1936: 957.

Ixodes areolaris, Olenev, 1939: 321 - 322.

Localities and Hosts

Asia

Arabia - (Olenev, 1931: 126 - 139). Asia Minor (Neumann, 1911: 12 - 13). China - (Neumann, 1911: 12 - 13; Olenev, 1931: 126 - 139); Shanghai (Olenev, 1929: 489 - 494). Japan - (Neumann, 1911: 12 - 13; Olenev, 1931: 126 - 139); Akita, on horse; Saga, on hare (Neumann, 1899: 16; Neumann, 1904: 452; Nuttall and Warburton, 1911: 143 - 156). Turkey - (Olenev, 1931: 126 - 139); Adrianople, on cattle (Markov, 1916: 313 - 315); Ardagona (Olenev, 1929: 489 - 494).

Europe

Europe - (Neumann, 1911: 12 - 13; Olenev, 1931: 126 - 139); western part (Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 37 - 43). Bulgaria - on cattle (Markov, 1916: 313 - 335). Denmark - (Olenev, 1934: 367 - 388). Finland (Kassel and Weber, 1900; Nuttall and Warburton, 1911: 143 - 156; Olenev, 1934: 367 - 388; Olenev, 1934: 672 - 674); Raivola, Tereoki (Olenev, 1929: 489 - 494). Germany - (Nuttall and Warburton, 1911: 143 - 156). Heligoland - (Nuttall and Warburton, 1911: 143 - 156). Hungary - on cattle (Kotlán, 1919: 34 - 35), on dogs, foxes, procupine, and weasel (Kotlán, 1921: 43 - 50). Jugoslavia - (Mlinac and Oswald, 1936: 415 - 421), on ox (Oswald, 1939: 305 - 306). Macedonia - on cattle (Markov, 1916: 313 - 315), on horses (Knuth, et al., 1918: 241 - 264). Rumania - (Knuth, et al., 1918: 241 - 264), on cattle (Cernaianu, 1937: 281 - 293). Sweden - (Olenev, 1934: 367 - 388; Olenev, 1934: 672 - 674). Thrace - on cattle (Markov, 1916: 313 - 315).

U. S. S. R.

U. S. S. R. - (Kurchatov and Kalmikov, 1934: 80 pp.); northern

part (Olenev, 1931: 126 - 139); northwestern, western, southwestern and southeastern parts (Olenev, 1934: 672 - 674); northwestern part (Olenev, 1941: 116); European parts (Pomerantzev, 1946: 8, 11), European and Asiatic parts (Olenev, 1929: 305 - 314).

Armenian S. S. R. - (Kirschenblatt, 1936: 93 - 97); northeastern regions, on goat (Lototzky and Popov, 1934: 67 - 80); Delizhan district (Pomerantzev and Matikashvili, 1940: 100 - 133).

Azerbaijan S. S. R. - (Kirschenblatt, 1936: 93 - 97), on zebu (Yakimov, et al., 1934: 235 - 254).

Byelorussian S. S. R. - (Chumakov, 1941: 65 - 67), on small rodents, man, horses, hedgehog, dog, cat (Naidenova, 1941: 20 - 21), birds, cattle (Naidenova, 1941: 20 - 21; Chumakov and Naidenova, 1944: 89 - 93), wild animals (Chumakov and Naidenova, 1944: 89 - 93), sheep (Zilber, 1945: 45 - 48); Vitebsk Province; Bobruysk Province; Mogilev Province: Postavy (Olenev, 1929: 489 - 494); Brest Province: Belovezh (Olenev, 1929: 489 - 494), on squirrel and small murids (Naidenova, 1941: 20 - 21); Grodno Province (Olenev, 1934: 672 - 674).

Estonian S. S. R. - (Pomerantzev, 1950: 37 - 43, on cattle (Olenev, 1939: 321 - 322); Revel; Hapsal; Kegel; and Birgas (Olenev, 1934: 672 - 674).

Georgian S. S. R. - (Kirschenblatt, 1936: 93 - 97); Kutaisi; Tibilisi (Olenev, 1929: 489 - 494).

Karelo - Finnish S. S. R. - (Olenev, 1934: 367 - 388; Chumakov, 1941: 65 - 67); southwestern and southern parts (Chumakov, et al., 1944: 83 - 89); Karel promontory (Pomerantzev, 1950: 37 - 43); Petrozavodsk (Olenev, 1929: 489 - 494); Petrozavodsk District; Prionezhsky District; in Kontschezero of Petrovsky District; Medvezhegorsky District and Segozersky Districts, on cattle (Kheisin, 1950: 572 - 574); south of Lake Onega (Olenev, 1936: 957).

Kazakh S. S. R. - (Olenev, 1929: 25 pp.); Iuzno-Kazakh Province: in Turkestan of Sir-Dariansk District (Olenev, 1929: 489 - 494); Sir-Dariansk District, on sheep and Phasianus colchicus turcestanicus (Olenev, 1930: 604 - 610).

Latvian S. S. R. - (Pomerantzev, 1950: 37 - 43); Riga; Pernov (Olenev, 1934: 672 - 674).

Lithuanian S. S. R. - (Olenev, 1934: 672 - 674; Pomerantzev, 1950: 37 - 43); Vilnius Province (Olenev, 1934: 672 - 674).

Moldavian S. S. R. - Akkerman District (Olenev, 1929: 489 - 494).

R. S. F. S. R. - (Olenev, 1934: 367 - 388; Yakimov, 1922: 41 - 46), on cattle (Marzinovsky, 1914: 714 - 735); central zone, on forest and field mice (Olsufiev, 1947: 255 - 262); northwestern part

(Yakimov and Vasilevskaya, 1924: 52 - 64; Yakimov and Vasilevskaya, 1926: 192 - 210; Olenev, 1926: 15 - 17), on cattle (Elmanov, 1930: 193; Olenev, 1934: 672 - 674); European part, on cattle (Yakimov, et al., 1926: 224 - 258); European and Asiatic parts, on cattle, horse, sheep, goat, deer, rabbit, mice, dog, cat, man (Olenev, 1928: 84 - 96); Briansk Province (Olenev, 1929: 489 - 494); Bukovina Province: northern part, on man (Kolachev and Kosovsky, 1949: 42 - 48); southwestern part of northern Bukovina (Gajdusek, 1953: 1 - 140); Gorki Province (Pomerantzev, 1950: 37 - 43); Kalinin Province (Chumakov, et al., 1944: 83 - 89; Pomerantzev, 1950: 37 - 43); Kaliningrad Province (Pomerantzev, 1950: 37 - 43); Kuibuishev Province: (Pomerantzev, 1950: 37 - 43), Schentalinsk District (Chumakov, 1944: 83 - 89); Leningrad Province: (Chumakov, 1944: 83 - 89; Alfeev, 1947: 11 - 12; Pomerantzev, 1950: 37 - 43), on cattle (Yakimov, et al., 1926: 224 - 258; Chizh, 1941: 58 - 60; Olenev, 1939: 321 - 322; Shcheglova, 1939: 83 - 101; Petrov, 1941: 29 - 31), domestic animals, sheep, Apodemus agrarius, Sorex araneus, Apodemus flavicollis, Evotomys glareolus, Erinaceus europaeus, Turdus species, Anthus trivialis (Shcheglova, 1939: 83 - 101; Alfeev, 1940: 23 - 25); western part, on cattle (Sudachenkov, 1941: 141 - 142); in western and southwestern districts between Gulf of Finland and Lakes Ladoga, Ilmen and Peipus (Sudachenkov, 1941: 141 - 142); in southern part in vicinity of Lake Selenger, on cattle (Olenev, 1941: 1 p.); Volhkov (Olenev, 1934: 672 - 674); Novgorod area, on birds, hares (Pavlovsky, 1935: 22 - 31; Pomerantzev, 1935: 32 - 111), cattle (Pavlovsky, 1935: 22 - 31; Pomerantzev, 1935: 32 - 111; Pomerantzev and Alfeev, 1936: 187 - 194), Erinaceus europaeus, sheep, horses, pigs (Pomerantzev, 1935: 32 - 111), small mammals, and hedgehogs (Pavlovsky, 1935: 22 - 31); Novgorodsky, Voldaisky and Demiansky Districts (Olenev, 1929: 489 - 494); on cattle in Oranienbaum, Volosov, Krasnoyvardeiski, Gdovski, Liadski, Luzhski, Porkhovski, Oredezhski, Batetzki, Chudovski, Malovisherski, Lychkovski, Pskovski, Novorzhevski, Dedovichski, Bezhanitzski and Krestetzki (Olenev, 1934: 672 - 674); in region of Tsheremenetzhi Lake in western part, on small rodents, Erinaceus europaeus and cattle (Alfeev, 1935: 111 - 136); Moscow Province: (Pomerantzev, 1950: 37 - 43); vicinity of Avdotino Village of Semenov Rural Soviet in Mikhnev District (Kalabukhov and Shubladze, 1946: 68 - 75); Novgorod Province: (Olenev, 1926: 15 - 17; Olenev, 1927: 354 - 368; Olenev, 1929: 489 - 494), on cattle (Olenev, 1924: 36 - 41; Pavlovsky, 1926: 14 pp.; Pavlovsky, 1928: 368 - 376; Olenev and Pomerantzev, 1928: 376 - 385; Pomerantzev and Blagoveshchensky, 1930: 401 - 420); Omsk Province(Olenev, 1929: 489 - 494); Orel Province: (Alfeev, 1947: 11 - 12), on cattle, dogs, cats,

hedgehogs, hares and wolf (Alfeev, 1939: 99 - 109); Penza Province: Behovsk, Serdobsk (Zasukhin, 1935: 1 - 159); Perm Province (Olenev, 1929: 489 - 494); Saratov Province: (Zasukhin, 1936: 461 - 470; Pomerantzev, 1950: 37 - 43); various districts in province, on cattle (Zasukhin, 1933: 31 - 46), Putorius eversmanni, Cricetus cricetus, wolves, Apodemus sylvaticus, hares, foxes, cattle, horse, sheep (Zasukhin, et al., 1936: 148 - 154), Erinaceus rumanicus (Zasukhin, 1936: 155 - 164; Zasukhin, et al., 1936: 148 - 154); near Saratov and Ekaterinov Districts (Zasukhin, 1935: 1 - 159), on Erinaceus rumanicus (Zasukhin, 1936: 219 - 226); Smolensk Province (Chumakov, 1944: 83 - 89; Pomerantzev, 1950: 37 - 43); Stalingrad Province: Nehaev (Zasukhin, 1935: 1 - 159); Velikiye Luki Province: Nelidovo District on cattle and man (Kalabukhov and Shubladze, 1946: 68 - 75); Voronezh Province: (Yakimov and Mizkevitsch, 1936: 161 - 162), on cattle (Kuznetsov, 1953: 441 - 443); Western Province: on cattle (Olenev, 1939: 321 - 322).

Tadzhik S. S. R. - North Gissar Valley (Galuzo, et al., 1935: 167 - 185).

Ukrainian S. S. R. - (Pomerantzev, 1950: 37 - 43); western part (Chumakov, 1941: 65 - 67); Zhitomir and Vasilkovka (Olenev, 1929: 489 - 494).

Abkhazskaya A. S. S. R. - Sukhumi (Olenev, 1929: 489 - 494). Adzharskaya A. S. S. R. - Batumi (Olenev, 1929: 489 - 494). Chuvash A. S. S. R. (Pomerantzev, 1950: 37 - 43). Crimean A. S. S. R. - (Kurchatov and Sokolov, 1940: 35; Pomerantzev, 1950: 37 - 43), on cattle and small mammals (Kurchatov, 1940: 32); Crimean State Forest Reservation, on deer, fox, hare, squirrel, wood mouse, field mouse, Capreolus capreolus capreolus, Meles meles tauricus, Garrulus iphigenia, Merula merula aterima, cattle, swine, lizards (Melnikova, 1953: 422 - 434). Daghestan A. S. S. R. - on dogs (Zolotarev, 1934: 217 - 227), Khasav-iurt; Stalin-aul of Buinak Veterinary District; Buinak, Beriklei; Derbent District, on cattle (Olenev and Kastrov, 1932: 28 - 30).

Altai Territory - Barnaul Province (Olenev, 1929: 489 - 494). Khabarovsk Territory - (Chumakov, et al., 1944: 83 - 89); southeastern part of coastal zone, on cattle, horses, man, small mammals and birds (Shpringgoltz-Shmidt, 1935: 137 - 186); Amur Region (Neumann, 1904: 452; Nuttall and Warburton, 1911: 143 - 156; Olenev, 1929: 489 - 494), on sheep and dogs (Popov, 1928: 15 - 18). Krasnoyarsk Territory - Kansk District and Minusinsk District (Olenev, 1929: 489 - 494). Primor Territory - (Olenev, 1929: 489 - 494). Western Territory - Kholmski, Penovski, Toropetzki, Velikolutzki (Olenev, 1934: 672 - 674).

Caucasia - (Neumann, 1899: 116; Nuttall and Warburton, 1911: 143 - 156; Neumann, 1911: 12 - 13; Kirschenblatt, 1936: 93 - 97; Pomerantzev, 1946: 8, 11); northern part (Pomerantzev, 1950: 37 - 43), on horses (Demidov, et al., 1944: 22), on cattle, goats, dogs (Zakharov, 1926: 53 - 59); eastern part of North Caucasus in Prikumsky District, on cattle (Olenev and Kastrov, 1932: 28 - 30); Kubansk District on Black Sea Shore (Olenev, 1929: 489 - 494). Central Asia - Sir-Dariensky District, on pheasant (Olenev, 1929: 489 - 494). Lower Volga Region - Urupinsk, Balandonsk, Arkadansk, Turkovsk (Zasukhin, 1935: 1 - 159). Siberia - central part (Olenev, 1929: 489 - 494); eastern part (Olenev, 1929: 489 - 494; Chumakov, et al., 1944: 83 - 89); western part (Olenev, 1929: 489 - 494; Chumakov, et al., 1944: 83 - 89).

Trans-Baikal - (Olenev, 1929: 489 - 494). Transcaucasia - (Pomerantzev, 1950: 37 - 43); western, central, eastern, including Talysh and southern part on cattle, sheep, goats, horses, dogs, lizards, Vipera renardi, small rodents, Apodemus sylvaticus (Pomerantzev and Matikashvili, 1940: 100 - 133); Surnabad, on fox, hare, and sheep (Nuttall and Warburton, 1911: 143 - 156). Ural and Pri-Ural - (Chumakov, 1944: 83 - 89).

On following hosts without definite indication of locality: sheep (Neumann, 1911: 12 - 13; Olenev, 1929: 489 - 494; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 37 - 43; Zasukhin, 1935: 1 - 159), Capra hircus (Neumann, 1911: 12 - 13), cattle (Neumann, 1911: 12 - 13; Olenev, 1929: 489 - 494; Olenev, 1931: 3 - 125; Pavlovsky, et al., 1932: 207 - 216; Olenev, 1934: 367 - 388; Pomerantzev, 1950: 37 - 43; Pavlovsky, 1945: 65 - 92; Zasukhin, 1935: 1 - 159), horse (Neumann, 1911: 12 - 13; Olenev, 1929: 489 - 494; Olenev, 1931: 3 - 125; Olenev, 1934: 367 - 388; Pomerantzev, 1950: 37 - 43; Zasukhin, 1935: 1 - 159), dog (Olenev, 1929; 489 - 494; Neumann, 1911: 12 - 13; Olenev, 1931: 3 - 125; Pavlovsky, et al., 1932: 207 - 216; Pomerantzev, 1950: 37 - 43; Zasukhin, 1935: 1 - 159), cat (Olenev, 1929: 489 - 494; Neumann, 1911: 12 - 13; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 37 - 43), hare (Pavlovsky, 1945: 65 - 92; Pomerantzev, 1950: 37 - 43), Siberian marmot, rabbit, pheasant, squirrel, dormouse, mouse (Olenev, 1929: 489 - 494), hedgehog, (Olenev, 1929: 489 - 494; Pavlovsky, et al., 1932: 207 - 216; Pavlovsky, 1945: 65 - 92; Pomerantzev, 1950: 37 - 43), groundhog (Olenev, 1929: 489 - 494; Pomerantzev, 1950: 37 - 43), man (Olenev, 1929: 489 - 494; Neumann, 1911: 12 - 13; Olenev, 1931: 3 - 125; Olenev, 1934: 367 - 388; Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 37 - 43; Zasukhin, 1935: 1 - 159), small rodents (Olenev, 1929: 489 - 494; Pavlovsky, et al., 1932: 207 - 216), birds (Olenev, 1929: 489 - 494; Olenev, 1931: 3 -

125; Pavlovsky, et al., 1932: 207 - 216; Pavlovsky, 1945: 65 - 92; Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 37 - 43), domestic animals (Olenev, 1931: 3 - 125; Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 37 - 43), large wild mammals (Olenev, 1931: 3 - 125; Pavlovsky, 1945: 65 - 92; Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 37 - 43), small mammals (Pomerantzev, 1946: 8, 11), Erinaceus transcaucasicus, Garrulus glandarius krynickii, Chloris chloris, Sitta europaea caucasica, Parus major, Turdus philomelos, Merula merula aterrima (Kirschenblatt, 1936: 93 - 97), elk, badger, field mouse, wood mouse, snakes, lizards (Pomerantzev, 1950: 37 - 43), Vulpes vulpes (Pomerantzev, 1950: 37 - 43; Zasukhin, 1935: 1 - 159), Canis lupus, Putorius eversmanni, Erinaceus rumanicus, Cricetus cricetus, Lepus europaeus, Microtus arvalis, Evotomys glareolus, Apodemus agrarius, Apodemus sylvaticus, Sorex species, Mustela nivalis (Zasukhin, 1935: 1 - 159).

Biology

Life history: Ovipositing females preferred dense grass and moss and usually sheltered under lumps of earth or in thick grass (Alfeev, 1935: 111 - 113). Under natural conditions the eggs developed in 8 weeks but in the laboratory with an average temperature of 25 - 30° C. it took only 3 weeks. The eggs were killed at a humidity of 50 to 80% (Olenev, 1924: 36 - 41).

Development of a single stage could last at least a year and some nymphs that engorged in the spring did not molt until the autumn of the following year. Maturation of adults similarly lasted at least a year (Alfeev, 1947: 11 - 12). As a result, the complete cycle in nature required not less than 3 calendar years (Alfeev, 1947: 11 - 12; Chizh, 1941: 58 - 60). If, however, ticks that began a given stage in the autumn did not feed until the second half of the next summer, they did not complete the stage until the autumn of the following year, so that each stage then required 2 years. A considerable proportion of ticks in a population was usually subjected to prolonged fasting and the complete life cycle from adult to adult in such cases required up to 6 years. This did not apply to the more southerly areas where development after feeding proceeded more rapidly (Alfeev, 1947: 11 - 12). Under laboratory conditions the life cycle was completed within a period varying from 6 months to about 5 years (Elmanov, 1930: 193).

Adults overwintered on the ground under cover of moss, fallen leaves and debris and in the spring they were found waiting on the

stems of grasses and small bushes for their hosts (Elmanov, 1930: 193). This species was found to be a 3 host tick (Pomerantzev, 1950: 37 - 43; Chizh, 1941: 58 - 60). Laboratory experiments showed that a high humidity was detrimental to females though they could withstand a temperature of -30° C. Though spring floods resulting from melting snow killed large numbers of adults, the eggs and larvae survived (Pomerantzev, 1935: 32 - 111).

Hosts of stages: Adult - horses (Knuth, et al., 1918: 241 - 264; Olenev, 1929: 489 - 494; Olenev, 1931: 3 - 125; Pomerantzev, 1935: 32 - 111; Zasukhin, et al., 1936: 148 - 154; Pomerantzev and Matikashvili, 1940: 100 - 133; Zasukhin, 1935: 1 - 159; Naidenova, 1941: 20 - 21), cattle (Olenev, 1929: 489 - 494; Olenev, 1931: 3 - 125; Pomerantzev, 1935: 32 - 111; Zasukhin, et al., 1936: 148 - 154; Pomerantzev and Matikashvili, 1940: 100 - 133; Zasukhin, 1935: 1 - 159; Naidenova, 1941: 20 - 21), sheep (Olenev, 1929: 489 - 494; Olenev, 1931: 3 - 125; Pomerantzev, 1935: 32 - 111; Zasukhin, 1936: 148 - 154; Pomerantzev and Matikashvili, 1940: 100 - 133; Zasukhin, 1935: 1 - 159), dog (Olenev, 1929: 489 - 494; Olenev, 1931: 3 - 125; Naidenova, 1941: 20 - 21; Pomerantzev and Matikashvili, 1940: 100 - 133; Zasukhin, 1935: 1 - 159), cat (Olenev, 1929: 489 - 494; Naidenova, 1941: 20 - 21; Olenev, 1931: 3 - 125), rabbit, Siberian marmot, squirrel, groundhog, dormouse, pheasant, mouse (Olenev, 1929: 489 - 494), hedgehog (Olenev, 1929: 489 - 494; Naidenova, 1941: 20 - 21; Shcheglova, 1939: 83 - 101; Pomerantzev, 1950: 37 - 43), domestic animals (Olenev, 1931: 3 - 125; Zasukhin, et al., 1936: 148 - 154; Pomerantzev, 1946: 8, 11; Pomerantzev, 1950: 37 - 43), wild animals (Olenev, 1931: 3 - 125; Pomerantzev, 1946: 8, 11), birds (Olenev, 1931: 3 - 125), man (Olenev, 1931: 3 - 125; Zasukhin, 1935: 1 - 159; Naidenova, 1941: 20 - 21; Pomerantzev, 1946: 8, 11), Erinaceus rumanicus (Zasukhin, et al., 1936: 148 - 154; Zasukhin, 1936: 219 - 226; Zasukhin, 1935: 1 - 159), Erinaceus europaeus (Alfeev, 1935: 111 - 136; Pomerantzev, 1935: 32 - 111), hares (Pomerantzev, 1935: 32 - 111; Pomerantzev, 1950: 37 - 43), pigs (Pomerantzev, 1935: 32 - 111), Putorius eversmanni (Zasukhin, et al., 1936: 148 - 154; Zasukhin, 1935: 1 - 159), Cricetus cricetus (Zasukhin, et al., 1936: 148 - 154; Zasukhin, 1935: 1 - 159), wolf (Zasukhin, et al., 1936: 148 - 154; Zasukhin, 1935: 1 - 159), elk, fox (Pomerantzev, 1950: 37 - 43), Apodemus agrarius and Anthus trivialis (Shcheglova, 1939: 83 - 101).

Nymph and larva - small rodents (Alfeev, 1935: 111 - 136; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 37 - 43), hares (Pomerantzev, 1935: 32 - 111; Pavlovsky, 1935: 22 - 31; Zasukhin, et al., 1936: 148 - 154; Melnikova, 1953: 422 - 434), Eri-

naceus europaeus (Pomerantzev, 1935: 32 - 111; Shcheglova, 1939: 83 - 101), hedgehogs (Pavlovsky, 1935: 22 - 31; Pomerantzev, 1950: 37 - 43), Erinaceus transcaucasicus, Garrulus glandarius krynickii, Chloris chloris, Sitta europaea caucasica, Parus major, Turdus philomelos, Merula merula aterrima (Kirschenblatt, 1936: 93 - 97), Apodemus sylvaticus (Zasukhin, et al., 1936: 148 - 154; Pomerantzev and Matikashvili, 1940: 100 - 133; Zasukhin, 1935: 1 - 159), fox (Zasukhin, et al., 1936: 148 - 154; Zasukhin, 1935: 1 - 159), lizards (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 37 - 43), Vipera renardi (Pomerantzev and Matikashvili, 1940: 100 - 133), dog, wolf, Erinaceus rumanicus, Cricetus cricetus, Lepus europaeus, Microtus arvalis, Evotomys glareolus, Apodemus agrarius, Sorex species, Microtus nivalis (Zasukhin, 1935: 1 - 159), small mammals, birds (Pomerantzev, 1946: 8, 11), snakes (Pomerantzev, 1950: 37 - 43), squirrels (Pomerantzev, 1950: 37 - 43: Melnikova, 1953: 422 - 434).

Nymph - horses (Knuth, et al., 1918: 241 - 264), Erinaceus europaeus (Alfeev, 1935: 111 - 136), birds (Pomerantzev, 1935: 32 - 111; Pavlovsky, 1935: 22 - 31; Shcheglova, 1939: 83 - 101; Naidenova, 1941: 20 - 21), Erinaceus rumanicus (Zasukhin, et al., 1936: 148 - 154; Zasukhin, 1936: 219 - 226), Putorius eversmanni, Cricetus cricetus, wolf (Zasukhin, et al., 1936: 148 - 154), Turdus species, Anthus trivialis (Shcheglova, 1939: 83 - 101), squirrel (Naidenova, 1941: 20 - 21), man (Pomerantzev, 1950: 37 - 43).

Larva - small rodents (Olenev, 1929: 489 - 494; Naidenova, 1941: 20 - 21), birds (Olenev, 1929: 489 - 494; Pomerantzev, 1935: 32 - 111; Pavlovsky, 1935: 22 - 31; Naidenova, 1941: 20 - 21), Erinaceus europaeus (Alfeev, 1935: 111 - 136), Erinaceus rumanicus (Zasukhin, et al., 1936: 148 - 154; Zasukhin, 1936: 219 - 226), Putorius eversmanni, Cricetus cricetus, wolf (Zasukhin, et al., 1936: 148 - 154), Sorex araneus, Apodemus flavicollis, Evotomys glareolus (Shcheglova, 1939: 83 - 101), experimentally on man (Pomerantzev, 1950: 37 - 43).

Seasonal activity: In the Petrozavodsk region of the Karelo-Finnish S. S. R. this species was found on cattle at the end of April and in the first half of May. Maximum infestation was observed at the end of June and in the middle of July while in August a marked decrease in numbers was observed due to a drop in temperature. In the beginning of September, when the weather was warm and dry, the number of ticks increased once more and they were found on cattle to the end of September. In regions north of 62° 15' N. latitude where cattle were examined daily during the entire summer isolated specimens were found only during June (Kheisin, 1950: 572 - 574).

In Leningrad Province cattle were infested in the spring soon

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after they came to pasture. The rate of infestation increased rapidly and then dropped until cattle were practically free of ticks by the end of June, but it began again in the autumn (Pomerantzev, 1935: 32 - 111; Pavlovsky, 1935: 22 - 31). Birds were heavily infested by nymphs at the end of June and in the beginning of July (Shcheglova, 1939: 83 - 101).

In Saratov Province one brood of adults occurred in the spring (April-May) and another in the autumn (August-October). Larvae and nymphs were active from May to the beginning of September (Zasukhin, et al., 1936: 148 - 154; Zasukhin, 1936: 219 - 226).

In Orel Province no summer aestivation was observed. Only a few adults were observed at the beginning of the grazing period but the numbers markedly increased in the spring as the weather became warmer. Ticks were present on animals throughout the summer but a gradual reduction occurred in the intensity of the infestation (Alfeev, 1939: 99 - 109).

In Saratov Province and in the Lower Volga Region they were active May-October (Zasukhin, 1935: 1 - 159). In Voronezh Province cattle were heavily infested from April to the first snowfall (Kuznetsov, 1953: 441 - 443).

In the Crimean A. S. S. R. wild and domestic animals were infested the entire year with maximum abundance in March, April, May and September, October, November and sometimes in December. The larvae actively attacked from the end of April to July and the nymphs were active in April, May, June and from the second half of November to January inclusive (Melnikova, 1953: 422 - 434; Kurchatov, 1940: 32).

In Transcaucasia the adults were active for almost the entire year and showed a maximum abundance in the spring (April-May) and in the fall (September-October). The larvae and nymphs occurred mainly during the summer months (May-September) (Pomerantzev and Matikashvili, 1940: 100 - 133).

Habitats: All stages were found in forest zones (Yakimov, et al., 1926: 224 - 258; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Olenev, 1934: 672 - 674; Pomerantzev, 1935: 32 - 111; Kirschenblatt, 1936: 93 - 97; Kurchatov, 1940: 32; Sudachenkov, 1941: 41 - 44; Naidenova, 1941: 20 - 21; Kuznetsov, 1953: 441 - 443). They also occurred in pastures and in the surrounding wet and boggy areas overgrown with shrubs and forest (Yakimov, et al., 1926: 224 - 258; Olenev, 1926: 15 - 17; Elmanov, 1930: 193; Zasukhin, et al., 1936: 148 - 154; Sudachenkov, 1941: 41 - 44; Naidenova, 1941: 20 - 21). The absence of ticks from open pastures was believed to be due to the prolonged occurrence of relative humidities below 75% which was the

lower limit for I. ricinus (Sudachenkov, 1941: 41 - 44). However, it was found to be widely distributed and most abundant in pastures situated on high, dry ground (Pomerantzev, 1935: 32 - 111). Within the pastures themselves the number of ticks were negligible in marshy areas covered with moss or sedges, in plains sparsely covered with a mixture of low pines, birches, and alders, in water meadows in which willows were growing and in mixed forests of tall trees. Fewer ticks were found on southern slopes than on the northern ones which were less exposed to the direct rays of the sun (Sudachenkov, 1941: 41 - 44). They did not occur either in the semi-desert zone or in the dry steppe zone and were only occasionally found in the mountainous semi-desert zone (Olenev, 1931: 3 - 125; Zasukhin, et al., 1936: 148 - 154).

Habits: Regular examinations in the morning and in the evening showed that 96.1% of the females dropped off the host during the day (Pomerantzev and Alfeev, 1936: 187 - 194).

Rearing methods: Ticks were kept upright in test tubes with cotton-wool stoppers. The bottom quarter of each tube was filled with dry pine sawdust and the rest of the tube contained a strip of crinkled filter paper. The lower layer of sawdust was moistened monthly with sterile water by means of a pipette. When it was desired to retard development, the tubes were placed in a refrigerator and the sawdust was moistened once in 2 months. In this way fed and unfed larvae and nymphs survived for up to two years at 4° C. One engorged female was kept singly in a tube but up to 100 engorged larvae or 50 nymphs could be kept in one tube (Olsufiev, 1941: 436 - 439).

Tick parasites: Larvae of the phorid Megaselia rufipes were repeatedly observed in test-tubes containing Ixodes ricinus collected in different parts of Leningrad Province. Larvae of M. rufipes were observed which evidently had emerged from the ticks and had destroyed all of the internal organs of some of them. These larvae pupated and adults emerged. Larvae of M. rufipes are known to be saprophytic and polyphagous but have not previously been recorded as attacking ticks, though some phorids parasitize beetles, ants and other arthropods (Olenev, 1941: 1 p.). Hunterellus hookeri received from Montana developed in nymphs of I. ricinus (Alfeev, 1940: 23 - 25).

Control Measures

Dipping tanks containing solutions of sodium arsenite were used

in control of this tick (Pavlovsky, 1926: 14 pp.; Pavlovsky, 1928: 368 - 376; Pavlovsky, 1935: 22 - 31). The sodium arsenite acted on larvae and nymphs partly as a contact poison and mortality averaged 85%. Unfed ticks were less resistant than partially or fully engorged ticks. On treated animals the mortality of the ticks increased with a rise in concentration and it decreased with the length of time that elapsed after treatment. A 0.16% solution was effective for less than 3 days and that containing 0.18% was effective for up to 4 days. Neither harmed the animals (Chizh, 1941: 58 - 60). A paraffin-soap emulsion containing 0.14% sodium arsenite was somewhat more effective than solutions of sodium arsenite alone but it caused severe injury to the skin and hair of treated animals (Pomerantzev and Blagoveshchensky, 1930: 401 - 420). Wood tar was added to solutions of sodium arsenite which contained from 0.08 to 0.19% arsenic. An increase in arsenic concentration increased the rate of mortality of ticks and reduced the fertility of the surviving females, but the effectiveness was attributed to the addition of the tar emulsions. In laboratory experiments with treated ticks at temperatures varying from 14.5 to 25.6° C. it was found that the rate of mortality increased at the higher temperatures and often reached 100% when the temperature was 34.2° C. The untreated ticks were not affected by these temperature increases.

Cattle should be dipped in the evening for in this way the ticks will have been subjected to the effect of the dip for at least one night before they drop off in the daytime (Pomerantzev and Alfeev, 1936: 187 - 194). Though the use of sodium arsenite in cold water was found to be effective as a spray it was concluded that dips were more effective (Olenev and Pomerantzev, 1928: 376 - 385).

To help eliminate tick infestation of cattle cultivated pastures should replace the present natural ones and any of the natural ones should be gradually turned into forest. Cultivated pastures should be separated from infested land by fields of crops to prevent these new pastures from being infested by ticks carried to them by wild hosts (Pomerantzev, 1935: 32 - 111). Pasture land should also be rotated (Pavlovsky, 1926: 14 pp.).

In laboratory experiments derris powder killed larvae in one-half to one hour and nymphs in 1 - 2 hours but the adults proved more resistant. Good results were given by a water extract of 1 1/2 grams of derris powder in 300 cc. of 2% soap solution which killed larvae in 10 - 20 minutes (Mironov, et al., 1940: 106 - 108). A powder of dried rhizomes of Acorus calamus when applied freely as a dust was not very toxic but the dust and extracts of it made with water or alcohol repelled I. ricinus. The powders or extracts were

not harmful to man or animals and the extract might be used to impregnate collars and wristbands of protective overalls (Mironov, 1940: 409 - 410). Cattle infested with I. ricinus were sprayed with a dilute paste of pyrethrum and then dusted with pyrethrum at a rate of about 85 grams per animal. However, re-infestation began on the sixth day after a heavy rain washed off the dust (Cherkassky, 1945: 24 - 27).

In winter tests the bark or buds of Prudus padus or the leaves of P. laureocerasus killed larvae in 15 minutes or less; the bark of Prudus padus killed nymphs in 10 - 15 minutes and females in 25 - 30 minutes. In spring tests the leaves of P. padus killed larvae in 7 to 10 minutes, the males in 10 - 15 minutes and the females in 25 to 30 minutes. The flowers of Prudus maackii killed males in 7 - 10 minutes and females in 25 - 30 minutes; the leaves of P. laureocerasus killed males in 10 - 15 minutes and females in 20 minutes. Larvae were killed in 17 - 25 minutes by lemond rind and by garlic bulbs and by the juice of lemon rind in 7 - 10 minutes and by onion juice in 40 minutes. They were immobilized in 10 - 15 minutes and killed in 2 - 4 hours by leaves of Thyia occidentalis (Olenev, 1950: 149 - 151; Olenev, 1950: 1119 - 1120).

Relation to Disease

Tularemia - I. ricinus was considered as of importance in the transmission of this disease (Zasukhin, 1936: 461 - 470) and it was found spontaneously infected in nature (Khatenever, 1942: 82 - 86; Olsufiev, 1947: 255 - 262). B. tularense survived in this tick from stage to stage (Karpov and Popov, 1944: 75 - 79). Cases of tularemia in man have resulted from persons going into the forests and from contact with ticks (Olsufiev, 1947: 255 - 262).

Haemorrhagic fever - Patients in the southwestern portion of Northern Bukovina gave a history of tick bites or contact with ticks. The presence of I. ricinus was established in this area and it was regarded as a possible vector (Kolachev and Kosovsky, 1949: 42 - 48; Gajdusek, 1953: 1 - 140).

Japanese encephalitis - In laboratory experiments the virus persisted for three months in I. ricinus and was transmitted by this tick (Chumakov, et al., 1945: 18 - 24).

Spring-Summer Encephalitis - I. ricinus experimentally and naturally transmitted this disease (Chumakov, 1941: 65 - 67; Chumakov, et al., 1945: 18 - 24; Chumakov and Naidenova, 1944: 89 - 93; Pomerantzev, 1950: 37 - 43). The discovery of naturally infected I.

ricinus (Chumakov, 1941: 65 - 67) and the occurrence of typical cases of Spring-Summer Encephalitis in Byelorussian S. S. R. where persulcatus did not occur led to the assumption that I. ricinus served as the vector in this area (Chumakov and Naidenova, 1944: 89 - 93). In laboratory experiments the virus persisted in I. ricinus for 12 months (Chumakov, et al., 1945: 18 - 24). The virus was transmitted from stage to stage, from generation to generation and to animals on which I. ricinus fed (Chumakov, 1941: 65 - 67; Chumakov, et al., 1945: 18 - 24; Chumakov and Naidenova, 1944: 89 - 93). Strains of the virus were also isolated from nymphs taken on rodents and from the brains of heavily infested voles collected in the forest reserve of Belovezh (Chumakov, 1941: 65 - 67). The virus found in the field mice was identical with the common Far Eastern type (Chumakov and Naidenova, 1944: 89 - 93).

Louping ill of sheep - The virus causing this disease was isolated from specimens of Ixodes ricinus in Byelorussia by Chumakov and he found that it caused symptoms in sheep somewhat similar to those caused by the virus of tick-borne encephalitis of the Russian Far East. However, in later studies it was found to cause different symptoms in sheep and it was concluded that it was actually the virus of louping ill (Zilber, 1945: 45 - 48). It was regarded as a vector of this disease (Pomerantzev, 1950: 37 - 43).

Piroplasmosis - This disease was transmitted to cattle by Ixodes ricinus (Marzinovsky, 1914: 714 - 735; Markov, 1916: 313 - 335; Kotlan, 1919: 34 - 35; Yakimov, 1922: 41 - 46; Yakimov and Vasilevskaya, 1924: 52 - 64; Olenev, 1924: 36 - 41; Zakharov, 1926: 53 - 59; Pavlovsky, 1926: 14 pp.; Yakimov, et al., 1926: 224 - 258; Yakimov and Vasilevskaya, 1926: 192 - 210; Olenev, 1926: 15 - 17; Pavlovsky, 1928: 368 - 376; Elmanov, 1930: 193; Olenev, 1931: 3 - 125; Olenev, 1934: 672 - 674; Pomerantzev, 1935: 32 - 111; Cernaianu, 1937: 281 - 293; Oswald, 1939: 304 - 306; Zasukhin, 1935: 1 - 159; Sudachenkov, 1941: 25 - 27) and was also reported to be a vector to goats, dogs (Zakharov, 1926: 53 - 59), zebus (Yakimov, et al., 1934: 235 - 254) and large ungulates (Pomerantzev, 1950: 37 - 43).

The disease was transmitted to healthy cattle by larvae, nymphs and adults that were offspring of females that had engorged on infected animals. Nymphs and adults taken from infected pastures did not transmit the disease, probably due to the small proportion of ticks infected in nature. Temperature had no effect upon the ability of the ticks to acquire the infection and transmission of the infection was not influenced by temperature. No relation could be traced between the number of parasites ingested by ticks and the subsequent rate of infection of their offspring, but ticks taken from

animals that had suffered from piroplasmosis 2 - 13 months before usually transmitted the infection to a much smaller percentage of their offspring than did those that engorged during an acute attack of the disease. The relationship between Babesia bovis and Ixodes ricinus differed from that of other forms of piroplasmosis and their tick vectors in that B. bovis evidently completed its development before the larvae hatched. For this reason the disease was transmitted by larvae, nymphs and adults (Sudachenkov, 1941: 25 - 27).

The disease was reported from Finland (Nuttall, et al., 1911: 143 - 156; 294 - 315), Karelo-Finnish S. S. R. (Kheisin, 1950: 572 - 574), northern and European Russia (Marzinovsky, 1914: 714 - 735; Yakimov, et al., 1926: 224 - 258; Yakimov and Vasilevskaya, 1926: 192 - 210; Olenev, 1926: 15 - 17; Pavlovsky, 1928: 368 - 376; Elmanov, 1930: 193; Olenev, 1934: 672 - 674; Yakimov, 1922: 41 - 46; Yakimov and Vasilevskaya, 1924: 52 - 64; Zasukhin, 1935: 1 - 159), Azerbaijan S. S. R. (Yakimov, et al., 1934: 235 - 254), Novgorod Province (Olenev, 1924: 36 - 41; Pavlovsky, 1926: 14 pp.), Leningrad Province (Pomerantzev, 1935: 32 - 111; Sudachenkov, 1941: 25 - 27), North Caucasus (Zakharov, 1926: 53 - 59), Hungary (Kotlán, 1919: 34 - 35), Rumania (Cernaianu, 1937: 281 - 293), northern Jugoslavia (Oswald, 1939: 304 - 306), Bulgaria, Turkey, Thrace and Macedonia (Markov, 1916: 313 - 335).

Bite reaction: Under experimental conditions the saliva of I. ricinus produced papules on human skin. The epidermal reaction was due chiefly to the effect of the saliva. Organs other than salivary glands, prepared as emulsions, produced various forms of irritation, but for practical reasons could be disregarded (Pavlovsky and Shtein, 1927: 574 - 586).

Ixodes semenovi Olenev

Ixodes semenovi Olenev, 1929: 489 - 494; Olenev, 1930: 604 - 610; Olenev, 1931: 2 - 125; Olenev, 1931: 126 - 139; Pomerantzev, 1946: 8; Pomerantzev, 1950: 71 - 73.

Localities and Hosts

Kazakh S. S. R. - Alexander's Mountains on Accentor collaris (Olenev, 1930: 604 - 610; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pomerantzev, 1946: 8); northern slope of Alexander's ridge,

Merke River in Aral Tube, on Accentor collaris (Olenev, 1929: 489 - 494); Northern slopes of Khirgiz Altai, at Merke River, in Aral-tube, on Prunella collaris (Pomerantzev, 1950: 71 - 73).

Biology

Hosts of stages: Only the female stage was described.

Seasonal activity: Females were collected in July (Pomerantzev, 1950: 71 - 73).

Habitat: This species was found in a mountainous landscape at an elevation of about 2000 meters (Olenev, 1931: 3 - 125; Pomerantzev, 1950: 71 - 73).

Ixodes signatus Birula

Ixodes signatus Birula, 1895: 357 - 358; Banks, 1908: 54; Nuttall and Warburton, 1911: 261 - 264; Olenev, 1928: 84 - 96; Kirschenblatt, 1936: 93 - 97; Pomerantzev, 1946: 9; Pomerantzev and Serdyukova, 1948: 47 - 67; Pomerantzev , 1950: 73 - 74.
Ixodes eudyptidis var. signata, Neumann, 1904: 451; Olenev, 1929: 305 - 314.
Ixodes parvirostris Neumann, 1901: 284; Banks, 1908: 54.
Ixodes eudyptidis signatus, Neumann, 1911: 21.

Localities and Hosts

Japan - (Kirschenblatt, 1936: 93 - 97; Pomerantzev, 1950: 73 - 74); on Phalacrocorax pelagicus (Neumann, 1911: 21); Yezo, on Phalacrocorax pelagicus (Neumann, 1901: 284; Nuttall and Warburton, 1911: 261 - 264). United States - Aleutian Islands (Olenev, 1928: 84 - 96), on Phalacrocorax pelagicus (Neumann, 1911: 21); Unalaska (Birula, 1895: 357 - 358; Nuttall and Warburton, 1911: 261 - 264; Kirschenblatt, 1936: 93 - 97); California (Kirschenblatt, 1936: 93 - 97; Pomerantzev, 1950: 73 - 74). U. S. S. R. - Primor Territory: Vladivostok, on Phalocrocorax pelagicus (Pomerantzev, 1950: 73 - 74), Phalacrocorax species (Kirschenblatt, 1936: 93 - 97); Far East (Pomerantzev and Serdyukova, 1948: 47 - 67).

Ixodes triangulicepS Birula

Ixodes triangulicepS Birula, 1895: 358; Neumann, 1911: 29; Nuttall and Warburton, 1911: 293; Olenev, 1927: 219 - 224; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev, 1934: 672 - 674; Kalabukhov and Shubladze, 1946: 68 - 75; Pomerantzev, 1946: 6, 9; Pomerantzev, 1950: 84 - 87.

Ixodes tenuirostris Neumann, 1901: 286; Neumann, 1911: 23; Nuttall and Warburton, 1911: 246 - 248; Olenev, 1927: 219 - 224; Olenev, 1931: 3 - 125.

Localities and Hosts

Europe

Great Britain - (Neumann, 1911: 23; Olenev, 1931: 126 - 139; Pomerantzev, 1946: 6, 9; Pomerantzev, 1950: 84 - 87). Switzerland - (Olenev, 1931: 126 - 139; Pomerantzev, 1946: 4, 9; Pomerantzev, 1950: 84 - 87). Germany - (Neumann, 1911: 23; Olenev, 1931: 126 - 139; Pomerantzev, 1946: 6, 9; Pomerantzev, 1950: 84 - 87).

U. S. S. R.

U. S. S. R. - Petserski Reservation (Pomerantzev, 1950: 84 - 87). Georgian S. S. R. - Dzaparidze (Pomerantzev, 1950: 84 - 87). R. S. F. S. R. - Velikye Luki Province: Nelidovo District, on Evotomys glareolus (Kalabukhov and Shubladze, 1946: 68 - 75); Moscow Province (Pomerantzev, 1950: 84 - 87).

Karelo-Finnish S. S. R. - on rodents (Olenev, 1931: 3 - 125); on shores of Lake Onega (Birula, 1895: 358; Neumann, 1911: 29; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Pomerantzev, 1950: 84 - 87), on field rodents (Olenev, 1928: 84 - 96); vicinity of Bryansk (Pomerantzev, 1946: 6, 9; Pomerantzev, 1950: 84 - 87); Olonetz region (Olenev, 1934: 672 - 674); Karelian Isthmus (Pomerantzev, 1950: 84 - 87). Ukrainian S. S. R. - Transcarpathian Province (Pomerantzev, 1950: 84 - 87).

Komi A. S. S. R. - upper region of Pechora River (Pomerantzev, 1946: 6, 9). Krasnoyarsk Territory - western Sayan Mountains (Pomerantzev, 1946: 6, 9); northern slope of western Sayan Mountains, Kulumyss Mountains (Pomerantzev, 1950: 84 - 87). Caucasia - northern part (Pomerantzev, 1950: 84 - 87).

On following hosts without definite indication of locality: small mammals, Evotomys rufocanus, mice and shrews (Pomerantzev, 1946: 6, 9); Clethrionomys glareolus, Clethrionomys glareolus hercynius, Clethrionomys glareolus britannicus, Clethrionomys rutilus, Clethrionomys rufocanus, Microtus arvalis, Microtus agrestis, Arvicola terrestris, Mus minutus, Apodemus flavicollis, Sorex minutus, Sorex vulgaris and Sorex araneus (Pomerantzev, 1950: 84 - 87).

Biology

Hosts of stages: Males were not found on the hosts (Pomerantzev, 1950: 84 - 87).

Seasonal activity: The larvae were most abundant in June and decreased in numbers in August under the conditions of the cedar-fir forests of the Western Sayan Mountains; the nymphs under similar conditions reached their peak of abundance in August; and females were found in July (Pomerantzev, 1950: 84 - 87).

Habitats: It was recorded from the timber zone in Karelo-Finnish S. S. R. (Olenev, 1931: 3 - 125) and in the cedar-fir forests on the northern slopes of the Western Sayan Mountains (Pomerantzev, 1950: 84 - 87).

Relation to Disease

Ixodes trianguliceps was found infected with the virus of Spring-Summer Encephalitis and was thought to be responsible for the propagation of the virus among smaller animals and for keeping the infection going in nature (Kalabukhov and Shubladze, 1946: 68 - 75).

Ixodes uriae White

Ixodes uriae White, 1852: 210; Nuttall and Warburton, 1911: 256 (?); Cooley and Kohls, 1945: 223; Bequaert, 1946: 140.
Ceratixodes uriae, Schulze, 1938: 12.
Hyalomma puta Pickard-Cambridge, 1876: 260; Pickard-Cambridge; 1879: 222; Neumann, 1899: 125; Neumann, 1911: 29; Nuttall and Warburton, 1911: 256.
Ixodes putus, Neumann, 1899: 125; Neumann, 1911: 29; Nuttall and War-

burton, 1911: 256 - 261, 317; Nuttall, 1912: 60; Nuttall, 1913: 74 - 86; Nuttall, 1915: 437 - 438; Olenev, 1927: 219 - 224; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev, 1934: 367 - 388; Shpringgoltz-Shmidt, 1935: 137 - 186; Johnston, 1937: 7; Pomerantzev and Serdyukova, 1940: 336 - 337; Pomerantzev, 1946: 6, 8; Cooley and Kohls, 1946: 223; Pavlovsky, 1947: 160 - 201; Pomerantzev and Serdyukova, 1948: 47 - 67; Pomerantzev, 1950: 87 - 89.

Ceratixodes putus, Neumann, 1902: 115; Lahille, 1905: 26, 138 - 148; Wheler, 1906: 415, 416; Nuttall and Warburton, 1911: 256; Neumann, 1911: 29; Kirschenblatt, 1936: 93 - 97.

Ixodes (Ceratixodes) putus procellariae Schulze, 1930: 123.

Ixodes borealis Kramer and Neumann, 1883: 526; Kramer and Neumann, in Evans, 1906: 85, 86.

Ixodes fimbriatus Kramer and Neumann, 1883: 527.

Ixodes hirsutus Birula, 1895: 356.

NOT Ixodes eudyptidis Haskell, 1885: 19 - 20.

All stages were found on certain marine birds and this species was recorded from North America, Iceland, the Faroes, the British Isles, northern Russia, Norway, Finland, Kamchatka, Commander Is., Campbell Is., New Zealand, South Georgia, and Antarctica, on Uria, Fratercula, Fulmarus, Sula, Larus, Rissa and Alca (Bequaert, 1946: 141). Though several authors have regarded Ixodes eudyptidis as a synonym of Ixodes uriae, Bequaert (1940) regarded it as a distinct species. All of the Russian workers have listed this species as Ixodes putus but Schulze (1938) recognized the oldest valid name as Ixodes uriae. Bequaert (1946) in agreement with Schulze, pointed out that the description of I. uriae, the recognizable figure, the host and locality data removed all possible doubt as to the identity of the name.

Localities and Hosts

(Only those records from Alaska, nearby islands, and the U. S. S. R. are cited here.) Alaska - (Neumann, 1911: 29 - 30); Aleutian Islands (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314); Unalaska (Neumann, 1911: 28); King Island (Neumann, 1911: 29 - 30). U. S. S. R. - Bering Island (Neumann, 1911: 29 - 30); Commander Island (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1934: 367 - 388; Pomerantzev, 1946: 6, 8; Olenev, 1950:

87 - 89); Kamchatka Province, on birds (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1934: 367 - 388; Pomerantzev, 1946: 6, 8; Pomerantzev, 1950: 87 - 89); Karlov Island (Pomerantzev, 1946: 6, 8; Pomerantzev, 1950: 87 - 89); on Rissa tridactyla, Uria troile, Uria lomvia (Kirschenblatt, 1936: 93 - 97); Kurile Islands (Pomerantzev, 1950: 87 - 89); Russian Far East (Shpringgoltz-Shmidt, 1935: 137 - 186; Pavlovsky, 1947: 160 - 201; Pomerantzev and Serdyukova, 1940: 336 - 337; Pomerantzev and Serdyukova, 1948: 47 - 67); Siberia (Neumann, 1911: 28).

On following hosts without definite indication of locality - penguins, sea gulls, cormorants and sometimes humans (Pomerantzev, 1946: 6, 8; Pomerantzev, 1950: 87 - 89).

Ixodes vespertilionis Koch, 1844

Ixodes vespertilionis Koch, 1844: 232; Koch, 1847: 21; Neumann, 1911: 30 - 31; Nuttall and Warburton, 1911: 271 - 277; Kotlán, 1921: 43 - 50; Olenev, 1927: 219 - 224; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Karpov and Popov, 1944: 75 - 79; Pomerantzev, 1946: 6, 8; Ogandzhanian, 1949: 219 - 222; Pomerantzev, 1950: 74 - 78.

Localities and Hosts

Europe

Europe - on bats (Nuttall and Warburton, 1911: 271 - 277; Olenev, 1931: 126 - 139; Pomerantzev, 1946: 6, 8), western part, on bats (Pomerantzev, 1950: 74 - 78). Germany, on bats (Nuttall and Warburton, 1911: 271 - 277). Czechoslovakia, in Moravia Province, on bats (Neumann, 1911: 30 - 31). Austro-Hungary, on bats (Nuttall and Warburton, 1911: 271 - 277). Hungary (Kotlán, 1921: 43 - 50).

Asia

Iran - northern regions, on bats (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Pomerantzev, 1950: 74 - 78). U. S. S. R. - (Olenev, 1927: 219 - 224). Western Siberia (Ruzskij, 1929: cited by Karpov and Popov, 1944: 75 - 79). Crimean A. S. S. R. - on bats (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Ole-

nev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pomerantzev, 1946: 6, 8; Pomerantzev, 1950: 74 - 78). Ukrainian S. S. R. - Transcarpathian Province: on bats (Pomerantzev, 1950: 74 - 78). Armenian S. S. R. - on bats (Pomerantzev, 1950: 74 - 78). Turkmen S. S. R. - on bats (Pomerantzev, 1946: 6, 8; Pomerantzev, 1950: 74 - 78).

Biology

Hosts of stages: All stages occurred on bats (Pomerantzev, 1950: 74 - 78).

Habitats: This species, which showed a preference for bats, was also recorded from caverns and grottos (Neumann, 1911: 30 - 31; Olenev, 1931: 3 - 125).

Rhipicephalus bursa Can. and Fanz.

Rhipicephalus bursa Canestrini and Fanzago, 1877-1878: 190; Neumann, 1911: 38 - 39; Nuttall, 1915: 434 - 448; Knuth, et al., 1918: 241 - 264; Kotlán, 1919: 34 - 35; Nuttall, 1919: 393 - 404; Yakimov, 1922: 41 - 46; Dzhunkovsky and Urodschevich, 1924: 107 - 110; Zakharov, 1926: 53 - 59; Olenev, 1928: 84 - 96; Olenev, 1929: 43 - 48; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev and Kastrov, 1932: 28 - 30; Zasukhin, 1933: 31 - 46; Olenev, 1934: 367 - 388; Lototzky and Popov, 1934: 67 - 80; Pavlovsky and Pomerantzev, 1934: 49 - 62; Pomerantzev, 1934: 63 - 66; Kurchatov and Kalmikov, 1934: 80 pp.; Zolotarev, 1934: 217 - 227; Yakimov, et al., 1934: 235 - 254; Zasukhin, 1935: 1 - 159; Kochetkov, 1935: 124 - 127; Mlinac and Oswald, 1936: 415 - 421; Oswald, 1938: 548 - 559; Zumpt, 1939: 400 - 409; Oswald, 1939: 170 - 173; Markov and Kurchatov, 1940: 33; Pomerantzev and Matikashvili, 1940: 100 - 133; Abramov, 1940: 33 - 34; Kurchatov and Sokolov, 1940: 35; Markov, et al., 1940: 33, Kurchatov, 1940: 32; Kurchatov, 1941: 97 - 103; Serdyukova, 1941: 135 - 144; Tzelishcheva, 1941: 34 - 36; Markov, 1941: 7 - 9; Markov, 1941: 22 - 23; Zumpt, 1942: 444 - 450; Chumakov, et al., 1945: 18 - 24; Lagereva, 1946: 9 - 14; Pomerantzev, 1946: 18, 21; Djaparidze, 1946: 377 - 380; Ogandzhanian, 1948: 231 - 244; Pomerantzev, 1950: 168 - 172; Pavlov and Guorguiev, 1950: 107 - 118; Melnikova, 1953: 422 - 434.

Localities and Hosts

Europe

Europe - southern part (Olenev, 1931: 126 - 139; Pomerantzev, 1946: 18, 21; Pomerantzev, 1950: 168 - 172). Bulgaria - (Olenev, 1934: 367 - 388; Pavlov and Guorguiev, 1950: 107 - 118). Hungary - on sheep (Kotlán, 1919: 34 - 35). Jugoslavia - (Mlinac and Oswald, 1936: 415 - 421; Oswald, 1938: 548 - 559); Dalmatia (Neumann, 1911: 38 - 39); Croatia (Neumann, 1911: 38 - 39); Serbia, on goats (Dzhunkovsky and Urodschevich, 1924: 107 - 110). Macedonia - on horses (Knuth, et al., 1918: 241 - 264). Rumania - (Neumann, 1911: 38 - 39; Knuth, et al., 1918: 241 - 264), Konstancia (Olenev, 1934: 367 - 388).

Asia

Asia - (Olenev, 1931: 126 - 139; Pomerantzev, 1946: 18, 21).

U. S. S. R.

U. S. S. R. - (Olenev, 1929: 43 - 48; Kurchatov and Kalmikov, 1934: 80 pp.; Zumpt, 1939: 400 - 409); southwestern part (Olenev, 1931: 3 - 125). Armenian S. S. R. - (Pomerantzev, 1946: 18, 21; Pomerantzev, 1950: 168 - 172), on goats, sheep, horses, cattle (Lototzky and Pokrovsky, 1934: 67 - 80; southwestern part (Pomerantzev, 1934: 63); central part, on sheep, cattle, horses (Pavlovsky and Pomerantzev, 1934: 49 - 62). Azerbaijan S. S. R. - (Kurchatov, 1941: 97 - 103; Pomerantzev and Matikashvili, 1940: 100 - 133), on zebu (Yakimov, et al., 1934: 235 - 254); Geokchay (Olenev, 1931: 3 - 125); Talysh (Pomerantzev and Matikashvili, 1940: 100 - 133). Georgian S. S. R. - (Pomerantzev and Matikashvili, 1940: 100 - 133).

R. S. F. S. R. - (Yakimov, 1922: 41 - 46; Olenev, 1934: 367 - 388); Grozny Province: Razdolnoe, on cattle (Olenev and Kastrov, 1932: 28 - 30); Saratov Province: Ozink (Zasukhin, 1933: 31 - 46); Stalingrad Province; Dubovka (Zasukhin, 1935: 1 - 159), on sheep and cattle (Zasukhin, 1933: 31 - 46); Kamyshin; Stalingrad (Zasukhin, 1933: 31 - 46); Kalach; Nekhavevsky (Zasukhin, 1935: 1 - 159).

Kazakh S. S. R. - western part in Slomikhin District (Olenev, 1934: 367 - 388; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 168 - 172), on sheep and cattle (Zasukhin, 1933: 31 - 46). Turkmen S. S. R. Askhabad Province: (Pomerantzev, 1946: 18, 21), Kara-Kala (Pomerantzev, 1950: 168 - 172). Ukrainian S. S. R. - Nikolayev Province:

Nikolayev (Olenev, 1934: 367 - 380).

Abkhazskaya A. S. S. R. - Sukhumi (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 168 - 172). Crimean A. S. S. R. - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pomerantzev, 1946: 18, 21; Pomerantzev, 1950: 168 - 172), on cattle (Markov, et al., 1940: 33; Kurchatov and Sokolov, 1940: 35), horse, sheep (Kurchatov and Sokolov, 1940: 35), domestic animals (Kurchatov, 1940: 32); southern part of Crimean State Forest Reservation, on cattle (Melnikova, 1953: 422 - 434). Daghestan A. S. S. R. - on cattle, horses, sheep (Zolotarev, 1934: 217 - 227); Buynaksk, on cattle, Baba-iurt, on cattle, DNKZ Veterinary District, on sheep (Olenev and Kastrov, 1932: 28 - 30).

Caucasia - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pomerantzev, 1946: 18, 21; Pomerantzev, 1950: 168 - 172); northern part, on cattle, sheep (Zakharov, 1926: 53 - 59). Central Asia - (Olenev, 1931: 126 - 139). Ciscaucasia - (Pomerantzev, 1950: 168 - 172). Lower Volga District- on sheep and cattle (Zasukhin, 1933: 31 - 46); Khvolinsky (Zasukhin, 1935: 1 - 159). Transcaucasia - on sheep (Lagereva, 1946: 9 - 14); eastern part (Pomerantzev, 1946: 18, 21); central and eastern part (Pomerantzev, 1950: 168 - 172); western, central and eastern parts, on cattle, buffalo, zebu, sheep, goat, horse, donkey, dog, hare (Pomerantzev and Matikashvili, 1940: 100 - 133). Transural Region - on domestic animals (Kochetkov, 1935: 124 - 127). Turkestan - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314).

On following hosts without definite indication of locality: cattle (Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 168 - 172), bison (Olenev, 1928: 84 - 96), sheep (Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 168 - 172), goat (Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 168 - 172), swine (Olenev, 1928: 84 - 96), horse (Olenev, 1928: 84 - 96; Pomerantzev, 1950: 168 - 172), donkey (Olenev, 1928: 84 - 96; Pomerantzev, 1950: 168 - 172), dog (Olenev, 1928: 84 - 96; Pomerantzev, 1950: 168 - 172), hedgehog (Olenev, 1928: 84 - 96), domestic animals, deer (Pomerantzev, 1946: 18, 21), hare (Pomerantzev, 1946: 18, 21; Pomerantzev, 1950: 168 - 172).

Biology

Life history: One generation occurred during the year (Markov and Kurchatov, 1940: 33). In the laboratory under optimum conditions and at a temperature of 25° C. the oviposition period lasted 21 - 23 days and the maximum daily number of eggs was always laid within the first quarter of the day. The total number laid by engorged females ranged from 4515 to 5036 eggs; partially engorged females laid 2017 to 3709 eggs. Partially engorged females did not have a shorter oviposition period but rather had a lower daily rate of egg production. Moderate fluctuations in atmospheric pressure had no apparent effect on the course of oviposition. The ticks died 1 - 2 days after oviposition ceased (Oswald, 1939: 170 - 173).

Hosts of stages: Adult - sheep (Kotlan, 1919: 34 - 35; Lototzky and Pokrovsky, 1934: 67 - 80; Olenev, 1931: 3 - 125; Pavlovsky and Pomerantzev, 1934: 49 - 62; Olenev, 1928: 84 - 96; Olenev and Kastrov, 1932: 28 - 31; Zasukhin, 1933: 31 - 46; Kurchatov and Sokolov, 1940: 35; Zasukhin, 1935: 1 - 159; Zakharov, 1926: 53 - 59; Pomerantzev and Matikashvili, 1940: 100 - 133; Lagereva, 1946: 9 - 14), goats (Dzhunkovsky and Urodschevich, 1924: 107 - 110; Lototzky and Pokrovsky, 1934: 67 - 80; Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125), horses (Knuth, et al., 1918: 241 - 264; Lototzky and Pokrovsky, 1934: 67 - 80; Pavlovsky and Pomerantzev, 1934: 49 - 62; Kurchatov and Sokolov, 1940: 35; Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1928: 84 - 96; Pomerantzev, 1950: 168 - 172), cattle (Lototzky and Pokrovsky, 1934: 67 - 80; Pavlovsky and Pomerantzev, 1934: 49 - 62; Olenev and Kastrov, 1932: 28 - 30; Zasukhin, 1933: 31 - 46; Kurchatov and Sokolov, 1940: 35; Markov, et al., 1940: 33; Melnikova, 1953: 422 - 434; Zakharov, 1926: 53 - 59; Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 168 - 172), zebu (Yakimov, et al., 1934: 235 - 254; Pomerantzev and Matikashvili, 1940: 100 - 133), domestic animals (Kurchatov, 1940: 32; Kochetkov, 1935: 124 - 127; Pomerantzev, 1946: 18, 21), buffalo (Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1928: 84 - 96), donkey (Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1928: 84 - 96; Pomerantzev, 1950: 168 - 172), dog (Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1928: 84 - 96; Pomerantzev, 1950: 168 - 172), swine, hedgehog (Olenev, 1928: 84 - 96).

Nymph - hare (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 18, 21; Pomerantzev, 1950: 168 - 172), horses (Knuth, et al., 1918: 241 - 264).

Nymph and larva - cattle (Pavlovsky and Pomerantzev, 1934: 49 - 62; Pomerantzev, 1950: 168 - 172; Pomerantzev and Matikashvili, 1940: 100 - 133), horses (Pavlovsky and Pomerantzev, 1934: 49 - 62; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 168 - 172), domestic animals (Kurchatov, 1940: 32; Pomerantzev, 1946: 18, 21), sheep, goats (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 168 - 172), deer (Pomerantzev, 1946: 18, 21; Pomerantzev, 1950: 168 - 172).

Seasonal activity: In Crimea the adults were active from March-August (Melnikova, 1953: 422 - 434; Kurchatov and Sokolov, 1940: 35), and were most numerous in May and June (Kurchatov, 1940: 32).

In Transcaucasia the adults appeared in May and reached a maximum peak of abundance at the end of May and at the beginning of June; later they decreased in numbers and the last ones were observed up to the last ten days of October. The larvae and nymphs appeared in the last ten days of September and reached a period of maximum activity in the first ten days of November (Pomerantzev and Matikashvili, 1940: 100 - 133).

In Armenia the adults appeared at the beginning of June and decreased about the end of July (Pavlovsky and Pomerantzev, 1934: 49 - 62). In western Kazakh and in the Lower Volga Region the adults were active in May (Zasukhin, 1935: 1 - 159).

Habitats: All stages were found in the steppe zone (Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev and Matikashvili, 1940: 100 - 133), semi-desert zone (Olenev, 1931: 3 - 125; Zasukhin, 1935: 1 - 159; Pomerantzev and Matikashvili, 1940: 100 - 133), mountain areas (Olenev, 1931: 3 - 125), forest zone (Olenev, 1931: 3 - 125; Pomerantzev and Matikashvili, 1940: 100 - 133), and in secondary pastures distributed within the boundaries of shrub formations (Pomerantzev and Matikashvili, 1940: 100 - 133).

Control Measures

It was suggested that sheep be removed from winter pastures (Pavlovsky and Pomerantzev, 1934: 49 - 62) and be taken to mountain pastures not later than either the first ten days of May before R. bursa appears in the valleys (Kurchatov and Sokolov, 1940: 35) or the latest about May 20 (Pavlovsky and Pomerantzev, 1934: 49 - 62). Animals which were particularly susceptible to piroplasmosis should be kept under observation from the time this species appears in mountain pastures. Cattle and horses should not descend the slopes of mountains covered with forests and infested with ticks (Kurchatov and

Sokolov, 1940: 35). However, the removal of sheep for three years will not render pastures free from infection since it was found that the ticks were still infective with B. ovis though they had fed on immune hosts for a considerable period (Markov and Kurchatov, 1940: 33).

Pyrethrum powders having a pyrethrin content of 0.4 - 1% were tested against this species and were used either alone or mixed with talc or ash, with a water suspension of pyrethrum powders with or without the addition of kerosene and soap, with an emulsion prepared from a paste having a pyrethrin content of 0.06 - 0.1% and with ointments made from pyrethrum powder and vaseline or similar substances. In the laboratory all preparations gave complete mortality of starved adults within 13 days, but a considerable percentage of engorged nymphs and adults survived. Under farm conditions practically all the adults on domestic animals were killed if they had not begun to feed. Pyrethrum powders were also found to prevent reinfestation, as all adults died when placed on animals 2 - 48 hours after treatment. The larvae died within a fortnight when placed on treated animals (Kurchatov, 1941: 97 - 103).

Good control was given within 24 hours by dipping domestic animals in a 2% emulsion of creolin with the addition of 0.1 - 0.11% As_2O_3 as sodium arsenite and also by dipping in a 2% suspension of pyrethrum powder (0.4% pyrethrins) with a 0.09% As_2O_3 (Lagereva, 1946: 9 - 14).

In laboratory experiments dusts of 5% BHC or DDT were tested against adults and eggs. When applied to adults in jars BHC killed a high proportion of males and unfed females and immobilized the rest in 24 hours and killed the partially engorged females in 3 - 5 days and the engorged females in 6 - 15 days. DDT killed unengorged females in a little over 24 hours, partially engorged females in 3 - 5 days and engorged females in 10 - 15 days; however, 5 of 9 engorged females oviposited on the tenth day after dusting and the eggs gave rise to viable larvae. When placed in jars on filter paper dusted with BHC or DDT the males and unfed females died in 48 hours and the partially engorged females died in 4 - 8 days and the engorged females in 24 days. Two of four engorged females exposed to DDT laid normal numbers of eggs six days after the beginning of the test and the resulting larvae were viable. Females which were dusted with BHC, washed in plain water 24 hours later and allowed to dry died 10 - 16 days later without ovipositing. Those dusted with DDT and similarly treated oviposited 5 days later. Eggs dusted with BHC and DDT did not hatch but those placed on dusted filter paper gave rise to viable larvae, though hatching was delayed and reduced by BHC

(Pavlov and Guorguiev, 1950: 107 - 118).

Relation to Disease

Piroplasmosis - R. bursa transmitted Babesiella, Babesia, Francaiella and Theileria (Pomerantzev, 1950: 168 - 172). It transmitted Babesia ovis to sheep (Yakimov, 1922: 41 - 46; Zakharov, 1926: 53 - 59; Olenev, 1931: 3 - 125; Pavlovsky and Pomerantzev, 1934: 49 - 62; Pomerantzev and Matikashvili, 1940: 100 - 133; Abramov, 1940: 33 - 34). This species harbored B. ovis for 7 generations and transmitted the infection to sheep even though the active stages of each generation were reared on immune animals, other than sheep. Batches taken from the second and third generations transmitted a severe form of piroplasmosis when fed on sheep, with one dying as a result of infection by ticks of the third generation. The virulence of the infection increased with the fourth generation of ticks and then remained at a level which caused sheep to die 2 - 3 days after the ticks became attached (Markov, 1941: 7 - 9; Markov and Kurchatov, 1940: 33). It also transmitted (Babesiella ovis, Francaiella ovis and Gonderia ovis to sheep (Pomerantzev and Matikashvili, 1940: 100 - 133), Babesia to goats (Dzhunkovsky and Urodschevich, 1924: 107 - 110), and cattle (Zakharov, 1926: 53 - 59) and Nuttallia equi to horses (Markov, et al., 1940: 33; Pomerantzev, 1950: 168 - 172).

Relapsing Fever - R. bursa was shown experimentally to retain the spirochaete of the Stalinabad strain of relapsing fever for not more than four days after the infecting feed and it was not able to pass the spirochaete on to its progeny (Serdyukova, 1941: 135 - 144).

Spring-Summer Encephalitis - The virus persisted for 13 days in R. bursa and that of Japanese (Mosquito borne) encephalitis for 14 days (Chumakov, et al., 1945: 18 - 24).

Tick Paralysis - Extracts made from eggs were inoculated into guinea pigs and 9 out of 12 died from paralysis; the surviving 3 showed no symptoms. The name ixovotoxin was suggested for the poison causing the paralysis. The duration of the paralysis appeared to be in an inverse relation to the amount of extract injected and the loss of body weight seemed to be proportional to the duration of the disease (Oswald, 1938: 548 - 559).

Anaplasmosis - R. bursa was found to be a vector of this disease (Pomerantzev, 1950: 168 - 172).

Rhipicephalus rossicus Yakimov and Kohl - Yakimova

Rhipicephalus rossicus Yakimov and Kohl - Yakimova, 1911: 739 - 745; Yakimov and Kohl - Yakimova, 1911: 416 - 425; Yakimov, 1923: 256 - 257; Olenev, 1928: 84 - 96; Yakimov, et al., 1928: 644 - 646; Olenev, 1929: 305 - 314; Olenev, 1929: 43 - 48; Olenev, 1934: 367 - 388; Zasukhin, 1935: 1 - 159; Kolomietz, 1936: 538 - 541; Zasukhin, 1936: 219 - 226; Zasukhin, 1936: 155 - 164; Zasukhin, 1936: 461 - 470; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 20, 21; Pomerantzev, 1950: 179 - 182; Shatas, 1952: 802 - 818.

Rhipicephalus sanguineus rossicus Zumpt, 1939: 400 - 409; Kurchatov, 1940: 32.

Localities and Hosts

Azerbaijan S. S. R. - (Pomerantzev, 1950: 174 - 182); Kirovabad, Zakataly; Nukha, Agdam (Pomerantzev and Matikashvili, 1940: 100 - 133). Armenian S. S. R. - (Pomerantzev, 1950: 179 - 182). Georgian S. S. R. - (Pomerantzev, 1950: 179 - 182). Kazakh S. S. R. - northern part up to Semiretchie (Pomerantzev, 1946: 20, 21; Pomerantzev, 1950: 179 - 182); western part, Slomikhin district on Hemiechinus auritus and Erinaceus rumanicus (Zasukhin, 1936: 219 - 226; Aktyubinsk Province: Irgiz district (Zasukhin, 1935: 1 - 159), on Hemiechinus auritus and Erinaceus rumanicus (Zasukhin, 1936: 219 - 226). R. S. F. S. R. - Astrakhan Province (Shatas, 1952: 802 - 818); Saratov Province: (Olenev, 1929: 305 - 314; Zasukhin, 1935: 1 - 159), on dogs (Yakimov, 1923: 256 - 257), hedgehogs (Olenev, 1928: 84 - 96); vicinity of Saratov (Olenev, 1934: 367 - 388), on Erinaceus rumanicus (Zasukhin, 1936: 219 - 226; Zasukhin, 1936: 155 - 164), Hemiechinus auritus (Zasukhin, 1936: 219 - 226), wild animals and cattle (Zasukhin, 1936: 461 - 470); Tersa-volsk on dog (Olenev, 1934: 367 - 388); Stalingrad Province: wild and domestic animals, Cricetus cricetus, man (Shatas, 1952: 802 - 818); Voronezh Province: Boguchar on cattle (Olenev, 1934: 367 - 388). Turkmen S. S. R. - Mary Province: Iolotan (Pomerantzev, 1950: 179 - 182). Ukrainian S. S. R. - (Pomerantzev, 1946: 20, 21; Pomerantzev, 1950: 179 - 182); southern part on hedgehogs, hares, horses, cattle, dogs, pigs, cats, man (Kolomietz, 1936: 538 - 541); Nikolayev Province: Nikolayev on dog (Olenev, 1934: 367 - 388). Crimean A. S. S. R. - (Kurchatov, 1940: 32). Daghestan, A. S. S. R. - (Pomerantzev, 1946: 20, 21; Pomerantzev, 1950: 179 - 182). Caucasia - (Pomerantzev, 1946: 20, 21); northern part on cattle (Yaki-

mov, 1928: 644 - 646). Lower Volga Region - (Pomerantzev, 1946: 20, 21; Pomerantzev, 1950: 179 - 182). Transcaucasia - (Pomerantzev, 1946: 20, 21); eastern part (Pomerantzev, 1950: 179 - 182); central, eastern and southern parts on cattle, buffalo, horses, dogs, hares (Pomerantzev and Matikashvili, 1940: 100 - 133).

On following hosts without definite indication of locality: Hemiechinus auritus, Cricetus cricetus, Lepus europaeus, Vulpes vulpes (Zasukhin, 1935: 1 - 159), Canis familiaris (Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 179 - 182), domestic animals, rabbit (Pomerantzev, 1946: 20, 21), hedgehog (Pomerantzev, 1946: 20, 21; Pomerantzev, 1950: 179 - 182), cattle, buffalo, hare, sheep, goat, camel, swine, horse (Pomerantzev, 1950: 179 - 182).

Biology

Life history: The cycle required 2 years for completion in nature (Shatas, 1952: 802 - 818) but it was completed in the laboratory in 77 - 108 days (Kolomietz, 1936: 538 - 541). In the laboratory females laid 200 - 6800 eggs (Kolomietz, 1936: 538 - 541).

Hosts of stages: Adult - Hemiechinus auritus (Zasukhin, 1936: 219 - 226; Zasukhin, 1935: 1 - 159), Erinaceus rumanicus (Zasukhin, 1936: 219 - 226; Zasukhin, 1935: 155 - 164), Canis familiaris (Yakimov, 1923: 256 - 267; Olenev, 1934: 367 - 388; Kolomietz, 1936: 538 - 541; Pomerantzev and Matikashvili, 1940: 100 - 133; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 179 - 182), hedgehogs (Olenev, 1928: 84 - 96; Kolomietz, 1936: 538 - 541; Pomerantzev, 1946: 20, 21; Pomerantzev, 1950: 179 - 182), cattle (Olenev, 1934: 367 - 388; Zasukhin, 1936: 461 - 470; Kolomietz, 1936: 538 - 541; Yakimov, 1928: 644 - 646; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 179 - 182), wild animals (Zasukhin, 1936: 461 - 470; Shatas, 1952: 802 - 818), domestic animals (Shatas, 1952: 802 - 818; Pomerantzev, 1946: 20, 21), Cricetus cricetus (Shatas, 1952: 802 - 818; Zasukhin, 1935: 1 - 159), man (Shatas, 1952: 802 - 818; Kolomietz, 1936: 538 - 541), hares (Kolomietz, 1936: 538 - 541; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 179 - 182), horses (Kolomietz, 1936: 538 - 541; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 179 - 182), swine (Kolomietz, 1936: 538 - 541; Pomerantzev, 1950: 179 - 182), cats (Kolomietz, 1936: 538 - 541), buffalo (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 179 - 182), Vulpes vulpes (Zasukhin, 1935: 1 - 159), Lepus europaeus (Zasukhin, 1935: 1 - 159), rabbit (Pomerantzev, 1946: 20, 21), sheep, goat, camel (Pomerantzev, 1950: 179 - 182).

Nymph and Larva - wild and domestic animals, Cricetus cricetus (Shatas, 1952: 802 - 818).

Seasonal activity: In Saratov Province and in western Kazakh the adults were active in June, July and August (Zasukhin, 1935: 1 - 159). In Stalingrad Province and in northern Astrakhan Province all stages began their activity in April with the larval stage more prevalent. In May the activity increased with adults and larvae predominating. The peak of activity for all stages was reached in June. In August no larvae or nymphs were found on domestic animals but some were found on wild animals. All activity ceased in October (Shatas, 1952: 802 - 818). In Transcaucasia all stages were active from April to September (Pomerantzev and Matikashvili, 1940: 100 - 133).

Habitats: All stages occurred in the wooded steppe zone, the steppe zone (Zasukhin, 1935: 1 - 159), the semi-desert zone (Zasukhin, 1935: 1 - 159: Pomerantzev and Matikashvili, 1940: 100 - 133), in areas of shrub vegetation, mixed forests and mountain steppes (Pomerantzev and Matikashvili, 1940: 100 - 133). They were also found in places of increased humidity and in well developed vegetation of the type found near rivers; but they were either completely absent or present in only small numbers in open meadows, fields, orchards and pastures (Shatas, 1952: 802 - 818).

Relation to Disease

R. rossicus was found spontaneously infected with Bacterium tularense in the spring-summer period when it readily attacked man (Shatas, 1952: 802 - 818) and was considered to be of importance in the transmission of this disease (Zasukhin, 1936: 461 - 470).

Rhipicephalus sanguineus (Latr.)

Ixodes sanguineus Latreille, 1806: 157.

Rhipicephalus sanguineus, Koch, 1844: 238 - 239; Neumann, 1911: 35 - 36, in part; Yakimov, 1917: 298 - 301; Knuth, et al., 1918: 241 - 264; Yakimov, 1923: 256 - 257; Zakharov, 1926: 53 - 59; Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1929: 43 - 48, in part; Olenev, 1930: 604 - 610; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Popov and Lototzky, 1932: 211 - 233; Olenev and Kastrov, 1932: 28 - 30; Zasukhin, 1933: 31 - 46; Elpatievsky, 1934: 127 - 130; Olenev, 1934: 367 - 387; Zolotarev, 1934: 217 -

227; Pomerantzev, 1934: 63 - 67; Kurchatov and Kalmikov, 1934: 80 pp.; Lototzky and Popov, 1934: 67 - 80; Zasukhin, 1935: 1 - 159; Schulze, 1935: 178 - 186; Pospelova-Shtrom, 1935: 115 - 134; Pospelova-Shtrom, 1935: 135 - 148; Mlinac and Oswald, 1936: 415 - 421; Zasukhin, 1936: 219 - 226; Zasukhin, 1936: 155 - 164; Zasukhin, 1936: 457 - 460; Oswald, 1938: 548 - 559; Agriinsky, 1938: 1 - 9; Aluimov, 1939: 118 - 119; Aluimov, et al., 1939: 41 - 54; Zumpt, 1939: 400 - 409; Aluimov, 1940: 338 - 339; Kurchatov, 1940: 32; Markov, et al., 1940: 34; Pomerantzev and Matikashvili, 1940: 100 - 133; Matikashvili, 1941: 55 - 61; Kurchatov, 1941: 97 - 103; Matikashvili and Dzhaparidze, 1942: 73 - 79; Karpov and Popov, 1944: 75 - 79; Chumakov, et al., 1945: 18 - 24; Pavlovsky, 1945: 65 - 92; Pomerantzev, 1946: 19, 21; Grobov, 1946: 59 - 63; Khayyat and Gilder, 1947: 119 - 126; Pletzity, 1947: 877 - 878; Petrova-Piontkovskaya, 1947: 173 - 176; Pavlovsky, 1948: 592 - 598; Pervomaisky, 1948: 35 - 40; Korshunova and Petrova-Piontkovskaya, 1949: 1151 - 1153; Pomerantzev, 1950: 172 - 176; Melnikova, 1953: 422 - 434.

Rhipicephalus turanicus Pomerantzev and Matikashvili, 1940: 100 - 133; Leonova, 1940: 33 - 36; Chumakov, et al., 1945: 18 - 24; Pomerantzev, 1946: 19, 21; Blagoveshchensky and Serdyukova, 1946: 75 - 89; Lagereva, 1946: 9 - 14; Petrova-Piontkovskaya, 1947: 173 - 176; Ogandzhanian, 1948: 231 - 244; Pervomaisky, 1948: 35 - 40; Pomerantzev, 1950: 176 - 179; Gajdusek, 1953: 1 - 140.

Localities and Hosts

Europe

Europe - southern part (Olenev, 1931: 126 - 139). Bulgaria - (Olenev, 1934: 367 - 388). Greece - (Neumann, 1911: 35 - 36). Jugoslavia - (Mlinac and Oswald, 1936: 415 - 421), Uskiub (Olenev, 1934: 367 - 388), southern Serbia (Oswald, 1938: 548 - 559). Macedonia - on horses (Knuth, et al., 1918: 241 - 264). Rumania - (Neumann, 1911: 35 - 36).

Asia

Asia - (Olenev, 1931: 126 - 139); southern part (Pomerantzev, 1950: 172 - 176). China - (Neumann, 1911: 35 - 36); Peking; eastern China (Olenev, 1934: 367 - 388). Iran - (Neumann, 1911: 35 - 36; Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 176 - 179). Iraq - on

sheep (Khayyat and Gilder, 1947: 119 - 126). Turkey - (Neumann, 1911: 35 - 36).

U. S. S. R.

U. S. S. R. - (Olenev, 1929: 43 - 48; Kurchatov and Kalmikov, 1934: 80 pp.; Aluimov, et al., 1939: 41 - 54; Zumpt, 1939: 400 - 409); southeastern part (Olenev, 1931: 3 - 125); European part (Pomerantzev, 1950: 172 - 176).

Armenian S. S. R. - (Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 172 - 176); Etschmiadzin, Erevan, Alagez, Bash - Norashen, Kulpy, Semenovka, Sovkhoz Parakat, Kamarlin, Kurdukuli, Uzunoba, Danalu, Gorovan, Zeiva, Doralagez-Armash, Beiuk-Vedy, Igdyr, Alishar, on sheep, cattle, horses, dogs and other large domestic animals (Pomerantzev and Matikashvili, 1940: 100 - 133); southwestern part, in valley of Arax River, on domestic mouse (Pomerantzev, 1934: 63 - 67); northeastern part, on sheep and cattle (Lototzky and Popov, 1934: 67 - 80).

Azerbaijan S. S. R. - on dogs (Markov, et al., 1940: 34), domestic animals (Kurchatov, 1941: 97 - 103); Baku, on dogs, horses, cattle, sheep, goats (Elpatievsky, 1934: 127 - 130); Kirovabad, Dzhebrail, Baku, Prishibinskaye, Talysh, Lenkoran, Nukha, Karyagino, Kazakh, Agdash, Salyany, on sheep, cattle, horses, dogs and other domestic animals (Pomerantzev and Matikashvili, 1940: 100 - 133).

Georgian S. S. R. - Poti, Kutaisi, Tibilisi, Gori, Lagodekhi, Zaolazan (Pomerantzev and Matikashvili, 1940: 100 - 133).

Kazakh S. S. R. - on camel, horse, cattle, dog, Lepus species, Erinaceus species (Olenev, 1930: 604 - 610); western part (Zasukhin, 1935: 1 - 159); Slomikhin district, on Hemiechinus auritus and Erinaceus rumanicus (Zasukhin, 1936: 219 - 226); Aktyubinsk Province: Irgiz (Zasukhin, 1933: 31 - 46), on Hemiechinus auritus and Erinaceus rumanicus (Zasukhin, 1936: 219 - 226); Kzyl-Orda Province: Kazalinsky (Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 176 - 179).

R. S. F. S. R. - (Yakimov, 1917: 298 - 301); Sergiopol, on camel; Lepsa, on cattle; Konur-ulen, on cattle (Olenev, 1934: 367 - 388); Grozny Province: Chernyy Rynok, on cattle; Razdolnoe, Talov Section, on cattle (Olenev and Kastrov, 1932: 28 - 30); Saratov Province: vicinity of Saratov (Zasukhin, 1933: 31 - 46), on Hemiechinus auritus and Erinaceus rumanicus (Zasukhin, 1936: 219 - 226; Zasukhin, 1936: 155 - 164).

Tadzhik S. S. R. - (Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 176 - 179; Blagoveshchensky and Serdyukova, 1946: 75 - 89), on Hemiechinus albulus, Meles meles, Lepus tolai bokhariensis (Pospelova-Shtrom, 1935: 115 - 134), cattle, sheep, goats, horses, dogs, donkeys

(Pospelova-Shtrom, 1935: 135 - 148); Gissar Valley, on domestic animals (Pavlovsky, 1945: 65 - 92), cattle, Khodzha-sodeyk, in Gissar Valley, on sheep and goats (Pospelova-Shtrom, 1935: 135 - 148); banks of Vakhsch river, on Crocidura russula, near Vakhsch river, on Rattus turkestanicus; Togul village, on Canis aureus aureus; Parkhar, on Mus musculus severzoni; below Lower Piandzh River, on Gasella subgutturosa subgutturosa (Pospelova-Shtrom, 1935: 115 - 134), Sarai-Kamar on cattle, sheep, goats (Pospelova-Shtrom, 1935: 135 - 148); Stalinabad Province: Varzobstroi on cattle; Kurgan Tyube on cattle, sheep, goats; Vakhshstroy, on cattle, sheep, goats (Pospelova-Shtrom, 1935: 135 - 148). Turkmen S. S. R. - Murghab Valley on domestic animals (Popov and Lototzky, 1932: 211 - 233); Ashkhabad Province: Krasnovodsk (Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 172 - 176); Karakalin (Pomerantzev, 1950: 172 - 176). Ukrainian S. S. R. - Kamenets-Podolskaya Province: Kamenets-Podolskiy (Olenev, 1934: 367 - 388). Uzbek S. S. R. - (Gajdusek, 1953: 1 - 140); Bukhara Province: Bukhara (Olenev, 1931: 3 - 125), Tashkent Province: Tashkent, on horses (Agriinsky, 1938: 1 - 9).

Abkhazskaya A. S. S. R. - Sukhumi (Pomerantzev and Matikashvili, 1940: 100 - 133). Crimean A. S. S. R. - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 19, 21; Grobov, 1946: 59 - 63; Pletzity, 1947: 877 - 878; Pomerantzev, 1950: 172 - 176), on dogs (Aluimov, 1939: 118 - 119; Korshunova and Petrova-Piontkovskaya, 1949: 1151 - 1153; Melnikova, 1953: 422 - 434), on cattle and other domestic animals (Kurchatov, 1940: 32). Daghestan A. S. S. R. - (Pomerantzev, 1950: 176 - 179), on cattle, horses, sheep, camels, dogs, cats (Zolotarev, 1934: 217 - 227); Baba-iurt, on cattle; Artel "Way to Socialism," on sheep; Stalin-aul of Buynaksk Veterinary District, on cattle; Buynaksk on cattle; Bereklei on cattle (Olenev and Kastrov, 1932: 28 - 30). Nakhichevanskaya A. S. S. R. - Schakhtakhty; Ordubad (Pomerantzev and Matikashvili, 1940: 100 - 133).

Caucasia - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Aluimov, 1939: 118 - 119; Pomerantzev, 1946: 19, 21); northern part, on dogs (Zakharov, 1926: 53 - 59); Atschikulak, on cattle; Aksai, on cattle (Olenev and Kastrov, 1932: 28 - 30). Central Asia - (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Aluimov, 1939: 118 - 119; Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 176 - 179). Ciscaucasia - (Pomerantzev, 1950: 176 - 179). Lower Volga Region - (Olenev, 1931: 126 - 139; Zasukhin, 1935: 1 - 159). Lower Trans-Volga Region - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314). Siberia - western part (Karpov and Popov, 1944: 75 - 79). Transcaucasia - (Olenev, 1928: 84 - 96), on buffalo (Pomerantzev and

Matikashvili, 1940: 100 - 133), sheep (Lagereva, 1946: 9 - 14); western part (Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 172 - 176), on dogs; Khoni, Bagdadi, Rokhi; Ukuta, Sairikh; Posiety; Sadilotrao; central part; eastern and southern parts on sheep, cattle, horses, dogs and other domestic animals; eastern part (Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 172 - 176); Gorovlu, Mingetschaur, Baladzhary, Adzhi-Kabul, Karatschaly, Schuschin, Dagtumas, Khailik, Alishar, Terter, Giarus; Nikolevka, Podar, Tchai-Tumas, Kuropatkino, Karakischliag, Pidzh, Kuikhet, Skobelevka, Kuirdamir, Zurnabad, Dzhafarkhan, Agakhanly, Adzhi-Kabul, Assuly, Gadzhi-Babaly, Dzham-Dzhamly, Kara-donly, Kara-Kagorly, Karabudzhar, Karaduly, Ovdzhuly, Petropavlovka, Surakhany, Faraba, Khazrin, Tsukhulsky, Schemokhin, Tscha-Khirly, on cattle, horse, sheep, goat, dog, swine, donkey, buffalo, camel, hare, cat, hen, Vormela sarmatica (Pomerantzev and Matikashvili, 1940: 100 - 133). Turkestan - (Olenev, 1928: 84 - 96; Olenev, 1929: 305 - 314).

On following hosts without definite indication of locality: horse (Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 172 - 176), camel (Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 172 - 176), sheep (Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 172 - 176), goat (Olenev, 1928: 84 - 96; Pomerantzev, 1950: 172 - 176), cattle, buffalo (Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 172 - 176), rodents (Olenev, 1928: 84 - 96), hedgehog (Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 172 - 176), turtle (Olenev, 1928: 84 - 96), man (Olenev, 1928: 84 - 96; Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 172 - 176), dog (Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 172 - 176), Lepus species (Olenev, 1931: 3 - 125), Lepus europaeus (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Hemiechinus auritus, Cricetus cricetus (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Meriones tamaricinus, Meriones meridianus (Zasukhin, 1935: 1 - 159), Vulpes vulpes (Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 172 - 176), domestic animals, rabbit, hamster (Pomerantzev, 1946: 19, 21), cats, hares, swine, jackal, donkey, Cricetulus phaeus, hen, Vormela sarmatica, domestic mouse, rat, Cricetulus migratorius, Microtus nivalis, Crocidura russula (Pomerantzev, 1950: 172 - 176).

Biology

Life history: R. sanguineus, a three host tick (Pomerantzev and

Matikashvili, 1940: 100 - 133), completed its cycle in 3 months (Pomerantzev, 1950: 172 - 176). Apparently there was one generation a year. Under room conditions those that dropped from a dog transformed into adults about mid-January, but none did so in the autumn. In nature, the last moult probably occurred in the spring. No larvae were found on dogs nor in the field and attempts to rear larvae from eggs were unsuccessful (Elpatievsky, 1934: 127 - 130).

Hosts of stages: Adult - horses (Knuth, et al., 1918: 241 - 264; Pomerantzev and Matikashvili, 1940: 100 - 133; Elpatievsky, 1934: 127 - 130; Olenev, 1930: 604 - 610; Pospelova-Shtrom, 1935: 135 - 148; Agriinsky, 1938: 1 - 9; Zolotarev, 1934: 217 - 227; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 172 - 176), sheep (Khayyat and Gilder, 1947: 119 - 126; Lototzky and Popov, 1934: 67 - 80; Pomerantzev and Matikashvili, 1940: 100 - 133; Elpatievsky, 1934: 127 - 130; Pospelova-Shtrom, 1935: 135 - 148; Zolotarev, 1934: 217 - 227; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 172 - 176), cattle (Lototzky and Popov, 1934: 67 - 80; Pomerantzev and Matikashvili, 1940: 100 - 133; Elpatievsky, 1934: 127 - 130; Olenev, 1930: 604 - 610; Olenev, 1934: 367 - 388; Olenev and Kastrov, 1932: 28 - 30; Pospelova-Shtrom, 1935: 135 - 148; Kurchatov, 1940: 32; Zolotarev, 1934: 217 - 227; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 172 - 176), dogs (Pomerantzev and Matikashvili, 1940: 100 - 133; Elpatievsky, 1934: 127 - 130; Markov, et al., 1940: 34; Olenev, 1930: 604 - 610; Pospelova-Shtrom, 1935: 135 - 148; Melnikova, 1953: 422 - 434; Zolotarev, 1934: 217 - 227; Zakharov, 1926: 53 - 59; Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 172 - 176), goat (Pomerantzev and Matikashvili, 1940: 100 - 133; Elpatievsky, 1934: 127 - 130; Pospelova-Shtrom, 1935: 135 - 148; Olenev, 1928: 84 - 96; Pomerantzev, 1950: 172 - 176), swine (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 172 - 176), donkey (Pomerantzev and Matikashvili, 1940: 100 - 133; Pospelova-Shtrom, 1935: 135 - 148; Pomerantzev, 1950: 172 - 176), buffalo (Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 172 - 176), camel (Pomerantzev and Matikashvili, 1940: 100 - 133; Olenev, 1930: 604 - 610; Olenev, 1934: 367 - 388; Zolotarev, 1934: 217 - 227; Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 172 - 176), hare (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 172 - 176), cat (Pomerantzev and Matikashvili, 1940: 100 - 133; Zolotarev, 1934: 217 - 227; Pomerantzev, 1950: 172 - 176), hen (Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 172 - 176), domestic animals (Pomerantzev and Matikashvili, 1940: 100 - 133; Kurchatov, 1941: 97 - 103; Pavlovsky, 1945: 65 - 92; Popov

and Lototzky, 1932: 211 - 233; Pomerantzev, 1946: 19, 21), Lepus species (Olenev, 1930: 604 - 610; Olenev, 1931: 3 - 125), Erinaceus species (Olenev, 1930: 604 - 610), Hemiechinus auritus (Zasukhin, 1936: 219 - 226; Zasukhin, 1936: 155 - 164; Zasukhin, 1935: 1 - 159; Zasukhin, 1933: 31 - 46), Erinaceus rumanicus (Zasukhin, 1936: 219 - 226; Zasukhin, 1936: 155 - 164), Hemiechinus albulus, Canis aureus aureus, Meles meles, Lepus tolai bokhariensis, Gasella subgutturosa subgutturosa (Pospelova-Shtrom, 1935: 115 - 134), hedgehog (Olenev, 1928: 84 - 96; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 172 - 176), rodents, turtle (Olenev, 1928: 84 - 96), man (Olenev, 1928: 84 - 96; Pomerantzev, 1946: 19, 21; Pomerantzev, 1950: 172 - 176), Cricetus cricetus, Lepus europaeus (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Meriones tamaricinus, Meriones meridianus (Zasukhin, 1935: 1 - 159), Vulpes vulpes (Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 172 - 176), hamster (Pomerantzev, 1946: 19, 21), jackal, Cricetulus phaeus (Pomerantzev, 1950: 172 - 176).

Nymph - dog (Elpatievsky, 1934: 127 - 130; Korshunova and Petrova-Piontkovskaya, 1949: 1151 - 1153), domestic animals (Kurchatov, 1941: 97 - 103; Kurchatov, 1940: 32), Hemiechinus albulus, Rattus turkestanicus (Pospelova-Shtrom, 1935: 115 - 134), cattle, Vormela sarmatica (Pomerantzev, 1950: 172 - 176).

Nymph and larva - domestic mouse, rat, Cricetulus migratorius, Microtus nivalis, Crocidura russula (Pomerantzev, 1950: 172 - 176).

Larva - domestic mouse (Pomerantzev, 1934: 63 - 67), Hemiechinus albulus, Crocidura russula, Rattus turkestanicus, Mus musculus severzoni (Pospelova-Shtrom, 1935: 115 - 134), domestic animals (Kurchatov, 1940: 32), cattle, Vormela sarmatica (Pomerantzev and Matikashvili, 1940: 100 - 133).

Seasonal activity: In Azerbaijan the adults and nymphs appeared in March and disappeared in October but they were abundant on dogs throughout the intervening period (Elpatievsky, 1934: 127 - 130). They showed two peaks of abundance; the first was in late May and early June and consisted mainly of adults (Elpatievsky, 1934: 127 - 130; Markov, et al., 1940: 34); the second peak in July consisted mainly of nymphs (Elpatievsky, 1934: 127 - 130).

In Transcaucasia the adults were active from March to September with a maximum in May - June and the nymphs were found singly in April and reached a peak in July - August (Pomerantzev and Matikashvili, 1940: 100 - 133). In Crimea the adults occurred from March - November (Melnikova, 1953: 422 - 434).

Habitats: All stages were found in the steppe zone (Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159),

semi-desert zone (Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev and Matikashvili, 1940: 100 - 133), desert zone (Olenev, 1931: 3 - 125), mountain steppes (Olenev, 1931: 3 - 125; Pomerantzev and Matikashvili, 1940: 100 - 133), forest steppes (Kurchatov, 1940: 32), in river valleys and along southern coast of Crimea (Kurchatov, 1940: 32), moist subtropical areas, mixed forests, grassy semi-steppe zone and areas of shrub vegetation (Pomerantzev and Matikashvili, 1940: 100 - 133). Engorged females and nymphs occurred in cracks in stone steps leading to a house (Elpatievsky, 1934: 127 - 130).

Control Measures

Promising results were obtained with pyrethrum powders having a pyrethrin content of 0.4 - 1% used either alone or mixed with talc or ash, with water suspensions of pyrethrum powders with or without the addition of kerosene and soap, with an emulsion prepared from a paste having a pyrethrin content of 0.06 - 0.1% and with ointment made from pyrethrum powder and vaseline or similar substances. Pyrethrum had a paralysing action and in the laboratory all preparations gave complete mortality of starved adults within periods ranging up to 13 days, but a considerable percentage of engorged nymphs and adults survived. In tests under farm conditions only single individuals survived. If they were feeding, however, the resistance of both nymphs and females was directly proportions to the degree to which they had engorged (Kurchatov, 1941: 97 - 103).

Of twenty-six substances tested in the laboratory the only ones which proved more of less effective as repellents were liquid carbolic acid, lysol, naptha-lysol, creolin, tar, mint-oil, turpentine, aniseed oil, clove oil, ethyl acetoacetate, coriander oil and a pinene obtained from juniper oil. Pyrethrum powder was not a repellent but killed ticks coming in contact with it. Of diluted preparations commonly applied in practice, the most effective was 10 - 30% carbolic acid, lysol, naptha-lysol or creolin in water. In experiments in the field the effectiveness of all substances was reduced (Blagoveshchensky and Serdyukova, 1946: 75 - 89).

Good results were obtained within 24 hours by dipping animals in a 2% emulsion of creolin with the addition of 0.1 - 0.11% As_2O_3 as sodium arsenite (Lagereva, 1946: 9 - 14).

Relation to Disease

Piroplasmosis - R. sanguineus was regarded as a probable vector to horses of Nuttallia equi (Knuth, et al., 1918: 241 - 264) and was shown experimentally to be a vector (Agriinsky, 1938: 1 - 9; Pomerantzev, 1950: 176 - 179). It transmitted Babesia canis to dogs (Zakharov, 1926: 53 - 59; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 172 - 176) and because of the association of the seasonal prevalence of this species with that of canine piroplasmosis it was regarded as a vector in Azerbaijan (Markov, et al., 1940: 34). This species was also regarded as a vector of piroplasmosis of swine (Pomerantzev, 1950: 176 - 179).

Marseilles Fever - R. sanguineus transmitted this disease in Crimea (Pletzity, 1947: 877 - 878; Aluimov, et al., 1939: 41 - 54; Pomerantzev, 1950: 172 - 176). The extent of infection of this species with rickettsiae was not even but many cases occurred within the area of distribution of R. sanguineus. The reservoirs of the disease were not known (Aluimov, 1940: 338 - 339). Rickettsiae causing Marseilles Fever were isolated from patients and from ticks collected in different localities (Aluimov, 1939: 118 - 119). Several strains of rickettsiae of Marseilles Fever were isolated from adults resulting from nymphs taken on dogs in Crimea (Korshunova and Petrova-Piontkovskaya, 1949: 1151 - 1153). The fever was produced in guinea pigs and in rabbits experimentally by injecting them with rickettsiae (Aluimov, et al., 1939: 41 - 54). The fever developed in guinea pigs 6 days after the ticks had fed on them and the engorged females from this feeding oviposited and the progeny, both larvae and nymphs, transmitted the fever to guinea pigs. Rickettsiae were found in smears of salivary glands, stomach and sex organs of females which resulted from infected nymphs, but none were found in the males (Korshunova and Petrova-Piontkovskaya, 1949: 1151 - 1153).

Tick Paralysis - Extracts made from eggs were inoculated into 6 guinea pigs and two of these died. The surviving guinea pigs did not show any symptoms. The name ixovotoxin was suggested for the causative agent of the paralysis. The duration of the experimental paralysis appeared to be in inverse relation to the amount of extract injected and the loss of body weight of the animals seemed to be proportional to the duration of the disease (Oswald, 1938: 548 - 559).

Spring-Summer Encephalitis - Attempts to infect R. sanguineus with the viruses of Spring-Summer Encephalitis, Japanese (mosquito-borne) encephalitis and Autumn (mosquito-borne) encephalitis were inconclusive, but the virus of Spring-Summer Encephalitis persisted for 22 days (Chumakov, et al., 1945: 18 - 24).

Haemorrhagic Fever - It was regarded as a possible vector of Uzbek Haemorrhagic Fever (Gajdusek, 1953: 1 - 140).

Rhipicephalus schulzei Olenev

Rhipicephalus schulzei Olenev, 1929: 43 - 48; Olenev, 1930: 604 - 610; Zasukhin, 1930: 250 - 262; Zasukhin, 1930: 555 - 571; Tikhomirova and Nikanorov, 1930: 60 - 61; Golov and Knyazevsky, 1930: 62 - 67; Zasukhin, 1931: 135 - 156; Pavlovsky, 1931: 73 - 84; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Kolpakova, 1931: 271 - 274; Gaisky, 1931: 59 - 61; Kolpakova and Lippert, 1932: 191 - 195; Zasukhin, 1933: 31 - 46; Zasukhin and Tiflov, 1933: 437 - 442; Olenev, 1934: 367 - 388; Kurchatov and Kalmikov, 1934: 80 pp.; Zasukhin, et al., 1934: 635 - 638; Zasukhin, 1935: 1 - 159; Zasukhin, 1935: 261 - 264; Zasukhin, 1936: 155 - 164; Zasukhin, 1936: 461 - 470; Zumpt, 1939: 400 - 409; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1946: 21, 23; Pavlovsky, 1948: 598 - 599; Pomerantzev, 1950: 187 - 190; Shatas, 1952: 802 - 818.

Rhipicephalus pumilio Schulze, 1935: 178 - 186; Zumpt, 1939: 400 - 409; Pomerantzev, 1946: 20, 21; Pomerantzev, 1950: 182 - 185; Shatas, 1952: 802 - 818.

Rhipicephalus leporis Pomerantzev, 1946: 19, 22; Pomerantzev, 1948: 20, 24; Pomerantzev, 1950: 185 - 187.

? Rhipicephalus pomerantzevi Muratbekov, 1945: 147 - 148; Muratbekov, 1948: 135 - 137.

Localities and Hosts

U. S. S. R.

U. S. S. R. - (Kurchatov and Kalmikov, 1934: 80 pp.; Zumpt, 1939: 400 - 409). Azerbaijan - on goat (Pomerantzev and Matikashvili, 1940: 100 - 133).

Kazakh S. S. R. - (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125), on camel, goat, Citellus pygmaeus, Citellus fulvus, Putorius eversmanni (Olenev, 1930: 604 - 610), Citellus species (Pavlovsky, 1931: 73 - 84); northwestern part (Olenev, 1929: 43 - 48; Shatas, 1952: 802 - 818); western part (Zasukhin, 1930: 250 - 262; Pomerantzev, 1946: 1 - 28), on Citellus pygmaeus (Tikhomirova and Nikanorov,

1930: 60 - 61; Golov and Knyazevsky, 1930: 62 - 67; Kolpakova and Lippert, 1932: 191 - 195), Putorius eversmanni (Golov and Knyazevsky, 1930: 62 - 67), sheep, goats, camel (Golov and Knyazevsky, 1930: 62 - 67; Kolpakova and Lippert, 1932: 191 - 195), dogs (Golov and Knyazevsky, 1930: 62 - 67), man, small mammals (Kolpakova and Lippert, 1932: 191 - 195), in nests of Ellobius talpinus (Gaisky, 1931: 59 - 61), on Citellus fulvus (Zasukhin, 1936: 155 - 164); Lbishchensk (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), on Citellus pygmaeus, Putorius eversmanni, other rodents and man (Kolpakova, 1931: 271 - 274); Talovka; Ushtagon; Ust-Urt (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159); Slomikhin (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Olenev, 1934: 367 - 388), Terel-yzak, Shores of Aral Sea, Maili-bash (Pomerantzev, 1950: 187 - 190); Aktyubinsk Province: Irgiz (Olenev, 1930: 604 - 610; Pomerantzev, 1950: 187 - 190; Olenev, 1934: 367 - 388); Chelkar (Olenev, 1934: 367 - 388); Kustanay Province: Turgay (Olenev, 1930: 604 - 610; Pomerantzev, 1950: 187 - 190); Yuzhno - Kazakh Province (Olenev, 1930: 604 - 610); Zapadno-Kazakh Province: Uralsk (Zasukhin, 1933: 31 - 46; Olenev, 1934: 367 - 388; Zasukhin, 1935: 1 - 159), on Citellus pygmaeus (Zasukhin, 1930: 555 - 571); Dzhambeyty; Urda; Novaya Kazanka; Kalmykova (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), Dzhanybek (Olenev, 1934: 367 - 388); Guryev Province: Guryev; Mangyshlak Peninsula (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159); Kzyl-Orda Province: Kazalinsk (Pomerantzev, 1950: 187 - 190).

Kirghiz S. S. R. - Issyk-Kul Province: Przhevalsk (Pomerantzev, 1950: 182 - 185).

R. S. F. S. R. - on sheep, camel, Citellus pygmaeus, Citellus fulvus, Cricetus cricetus, Cricetulus migratorius, Rhombomys opimus, Putorius eversmanni (Zasukhin, 1935: 261 - 264); southeastern part on Citellus pygmaeus (Zasukhin, 1931: 135 - 156; Zasukhin and Tiflov, 1933: 437 - 442), on Rhombomys opimus (Zasukhin, et al., 1934: 635 - 638); Astrakhan Province: (Pomerantzev, 1946: 21, 23); northern part (Pomerantzev, 1950: 182 - 185); northeastern part, Nikolaisky district on hare and in hole of Citellus pygmaeus (Shatas, 1952: 802 - 818); Saratov Province: (Zasukhin, 1936: 461 - 470); Novouzensk (Zasukhin, 1935: 1 - 159); Stalingrad Province: on Citellus pygmaeus Putorius eversmanni, hedgehog, house mouse, hare, fox, sand rat, man (Shatas, 1952: 802 - 818); Kalach (Zasukhin, 1935: 1 - 159).

Tadzhik S. S. R. - Piandzh Valley (Pomerantzev, 1950: 182 - 185). Turkmen S. S. R. - Repetek; Cheleken Island in Caspian Sea; Chardzhou Province: Chardzhou (Pomerantzev, 1950: 182 - 185). Uzbek S. S. R. - Barsa Kelmes Island; Nikolaia Island; Baga-Abzol; Samarkand Province: Samarkand; Fergana Province: Fergana (Pomerantzev, 1950: 182 - 185;

187 - 190); Bukhara Province: Bukhara (Pomerantzev, 1950: 182 - 185); Kenimekhski district on hares (Pomerantzev, 1948: 20 - 24; Pomerantzev, 1946: 21, 23; Pomerantzev, 1950: 185 - 187), hedgehogs (Pomerantzev, 1950: 185 - 187).

German-Volga A. S. S. R. - (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159). Central Asia - (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 21, 23; Pomerantzev, 1950: 182 - 185). Lower Volga Region - (Olenev, 1929: 43 - 48; Zasukhin, 1930: 250 - 262; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46). Transcaucasia - eastern part (Pomerantzev, 1946: 21, 23; Pomerantzev, 1950: 187 - 190).

On following hosts without definite indication of locality: camels (Olenev, 1929: 43 - 48; Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1946: 21, 23; Pomerantzev, 1950: 182 - 185), Citellus species (Olenev, 1929: 43 - 48; Olenev, 1931: 3 - 125), Putorius species (Olenev, 1929: 43 - 48; Olenev, 1931: 3 - 125; Pomerantzev, 1950: 187 - 190; Pomerantzev, 1946: 21, 23), sheep (Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1946: 21, 23; Pomerantzev, 1950: 187 - 190), goat (Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 187 - 190), dog (Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1946: 21, 23; Pomerantzev, 1950: 187 - 190), cat (Zasukhin, 1933: 31 - 46), man (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1946: 21, 23; Pomerantzev, 1950: 187 - 190), Putorius eversmanni (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 187 - 190), Citellus pygmaeus (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 187 - 190), Citellus fulvus (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 187 - 190), Marmota bobac (Zasukhin, 1933: 31 - 46), Cricetus cricetus (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 187 - 190), Mus musculus (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 187 - 190), Mesocricetus eversmanni (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 187 - 190), Hemiechinus species (Zasukhin, 1933: 31 - 46; Pomerantzev, 1950: 187 - 190), cattle (Zasukhin, 1935: 1 - 159; Pomerantzev, 1950: 182 - 185), Hemiechinus auritus, Lepus europaeus, Arvicola amphibius, Microtus arvalis, Meriones tamaricinus, Meriones meridianus, Alactaga jaculus, Alactagulus acontion, Lagurus lagurus (Zasukhin, 1935: 1 - 159), marmot, Mustela species, hare, swine, horse (Pomerantzev, 1950: 187 - 190, 182 - 185), hedgehog, rabbit, jackal (Pomerantzev, 1946: 21, 23; Pomerantzev, 1950: 187 - 190, 182 - 185), small mammals, domestic animals (Pomerantzev, 1946: 21, 23).

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Biology

Life history: The female oviposited for 10 - 50 days in the summer or for a longer period in the autumn. Lack of humidity caused mortality of both ticks and eggs. The eggs hatched in 17 - 35 days and the cycle from egg to adult lasted 75 - 150 days. In several instances larval skins were found attached to the host indicating that larvae may moult on it. All stages showed resistance to starvation and larvae lived without feeding for 8 months, nymphs for 7 months and adults for 10 months (Kolpakova and Lippert, 1932: 191 - 195). In nature the eggs were probably deposited in the spring (Kolpakova and Lippert, 1932: 191 - 195; Kolpakova, 1931: 271 - 274). There was some evidence that adults hibernated (Kolpakova, 1931: 271 - 274) in the nests of Citellus (Zasukhin, 1930: 555 - 571).

Hosts of stages: Adult - camel (Olenev, 1929: 43 - 48; Olenev, 1930: 604 - 610; Golov and Knyazevsky, 1930: 62 - 67; Olenev, 1931: 3 - 125; Kolpakova and Lippert, 1932: 191 - 195; Pomerantzev, 1946: 21, 23; Pomerantzev, 1950: 182 - 185), Citellus species (Olenev, 1929: 43 - 48; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 21, 23), Putorius species (Olenev, 1929: 43 - 48; Olenev, 1931: 3 - 125; Pomerantzev, 1946: 21, 23), sheep (Olenev, 1930: 604 - 610; Golov and Knyazevsky, 1930: 62 - 67; Olenev, 1931: 3 - 125; Kolpakova and Lippert, 1932: 191 - 195; Pomerantzev, 1946: 21, 23), goat (Olenev, 1930: 604 - 610; Golov and Knyazevsky, 1930: 62 - 67; Olenev, 1931: 3 - 125; Kolpakova and Lippert, 1932: 191 - 195; Pomerantzev and Matikashvili, 1940: 100 - 133; Pomerantzev, 1950: 182 - 185), Citellus pygmaeus (Olenev, 1930: 604 - 610; Zasukhin, 1930: 555 - 571; Golov and Knyazevsky, 1930: 62 - 67; Kolpakova and Lippert, 1932: 191 - 195; Zasukhin, 1935: 261 - 264), Citellus fulvus (Olenev, 1930: 604 - 610; Zasukhin, 1935: 261 - 264), Putorius eversmanni (Olenev, 1930: 604 - 610; Golov and Knyazevsky, 1930: 62 - 67), dogs (Golov and Knyazevsky, 1930: 62 - 67; Olenev, 1931: 3 - 125; Kolpakova and Lippert, 1932: 191 - 195); Pomerantzev, 1946: 21, 23; Pomerantzev, 1950: 182 - 185), man (Kolpakova and Lippert, 1932: 191 - 195; Pomerantzev, 1946: 21, 23; Pomerantzev, 1950: 182 - 185), hares (Pomerantzev, 1948: 20 - 24; Pomerantzev, 1950: 182 - 185; Shatas, 1952: 802 - 818), hedgehog, rabbit, jackal (Pomerantzev, 1946: 21, 23; Pomerantzev, 1950: 182 - 185), domestic animals (Pomerantzev, 1946: 21, 23), swine, horse, cattle (Pomerantzev, 1950: 182 - 185).

Nymph - Citellus pygmaeus (Zasukhin, 1930: 555 - 571; Kolpakova, 1931: 271 - 274; Kolpakova and Lippert, 1932: 191 - 195; Zasukhin, 1935: 261 - 264), small mammals (Kolpakova and Lippert, 1932: 191 -

195), Citellus fulvus (Zasukhin, 1935: 261 - 264), Citellus species (Pomerantzev, 1946: 21, 23), hedgehog (Pomerantzev, 1950: 185 - 187, 182 - 185), hare, rabbit (Pomerantzev, 1950: 182 - 185).

Larva - Citellus pygmaeus (Zasukhin, 1930: 555 - 571; Kolpakova and Lippert, 1932: 191 - 195; Zasukhin, 1935: 261 - 264), small mammals (Kolpakova and Lippert, 1932: 191 - 195). Citellus fulvus (Zasukhin, 1935: 261 - 264), Citellus species (Pomerantzev, 1946: 21, 23), hedgehog, hare (Pomerantzev, 1950: 185 - 187).

Seasonal activity: In Stalingrad Province and in the northern districts of Astrakhan Province all stages began their activity in April (rarely March) and disappeared in October. Most of the ticks in April were nymphs but larvae and some adults were also present. The larvae were most abundant in May; the nymphs were most prevalent in June reaching a peak in July; and the adults were most numerous in August but some larvae and nymphs were still present (Shatas, 1952: 802 - 818).

In western Kazakh the larvae were most numerous in May; the nymphs were prevalent in mid-May and in June; and the adults were active from mid-May to mid-September. The larvae and nymphs decreased in numbers in July and the adults became more abundant. The larvae and nymphs appeared again in August but were comparatively rare by September and October (Zasukhin, 1930: 555 - 571; Kolpakova, 1931: 271 - 274; Kolpakova and Lippert, 1932: 191 - 195; Zasukhin, 1935: 1 - 159).

Habitats: All stages were found in the steppe zone (Tikhomirova and Nikanorov, 1930: 60 - 61; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159), semi-desert zone (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159; Pomerantzev and Matikashvili, 1940: 100 - 133; Shatas, 1952: 802 - 818) and in the desert zone (Olenev, 1931: 3 - 125).

Relation to Disease

Plague - R. schulzei was a suspected vector of plague to man and animals (Zasukhin, 1930: 250 - 262; Pavlovsky, 1931: 73 - 84). Bacillus pestis occurred in cultures prepared from ticks found on Citellus pygmaeus dying of plague and it also occurred in guinea pigs infected by injection of a tick emulsion. Ticks preserved the bacillus longer than fleas (Tikhomirova and Nikanorov, 1930: 60 - 61). Infected ticks might easily pass to domestic animals grazing in areas where an epizootic among ground squirrels occurred and might easily be carried by the domestic animals to new places as they moved from pasture to pasture. They might also pass to man and infect him, at any rate by being

crushed as they were removed (Golov and Knyazevsky, 1930: 62 - 67).

Tularemia - R. schulzei was suspected of transmitting tularemia (Zasukhin, 1936: 461 - 470; Pomerantzev, 1950: 187 - 190) and was shown to be experimentally capable of transmission (Pomerantzev, 1950: 187 - 190).

Piroplasmosis - R. schulzei transmitted Babesia kolzovi to Citellus pygmaeus (Zasukhin, 1931: 135 - 156; Zasukhin, 1930: 555 - 571; Zasukhin, 1935: 261 - 264; Pomerantzev, 1950: 187 - 190) and epizootics invariably occurred in localities where they were heavily infested with larvae and nymphs (Zasukhin, 1930: 555 - 571). It was regarded as a probable vector of Babesia volgensis to Citellus fulvus (Zasukhin, 1936: 155 - 164).

Family Argasidae

Argas persicus (Oken)

Rhynchoprion persicum Oken, 1818: 1567.

Argas persicus, Fischer de Waldheim, 1823: 269; Nuttall, et al., 1908: 8 - 22, 81 - 90; Neumann, 1911: 121; Marzinovsky, 1914: 714 - 735; Yakimov, et al., 1916: 227 - 228; Markov, 1916: 313 - 335; Yakimov, 1917: 298 - 301; Wright and Harold, 1920: 203 - 217; Harold, 1920: 484 - 498; Yakimov, 1922: 41 - 46; Olenev, 1926: 13 - 14; Korovnikov, 1926: 81 - 86; Olenev, 1927: 546 - 549; Olenev, 1927: 219 - 224; Moskvin, 1927: 375 - 380; Martini, 1928: 1 - 134; Olenev, 1929: 25 pp.; Yakimov and Rastegaeva, 1929: 764 - 765; Olenev, 1929: 305 - 314; Olenev, 1930: 604 - 610; Sofiev, 1930: 43 - 46; Yakimov and Rastegaeva, 1930: 223 - 240; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Faddeeva, 1932: 273 - 279; Sadovsky, 1932: 20 - 26; Popov and Lototzky, 1932: 211 - 233; Zasukhin, 1933: 31 - 46; Olenev, 1934: 367 - 388; Pomerantzev, 1934: 63 - 66; Zasukhin, 1935: 1 - 159; Klimentova and Perfilev, 1935: 71 - 88; Aluimov, 1936: 54 - 67; Oswald, 1937: 265 - 273; Zasukhin, 1936: 457 - 460; Rastegaeva and Kolabsky, 1940: 408 - 410; Tzelishcheva, 1941: 34 - 36; Bernadskaya, 1944: 44; Nikolsky, 1948: 29 - 33; Skrynnik, 1948: 265 - 274; Olenev, 1950: 1119 - 1120; Pavlov and Guorguiev, 1950: 107 - 118; Shustrov, 1951: 393 - 397.

Localities and Hosts

Europe

Europe - southern part (Olenev, 1931: 126 - 139). Bulgaria - (Pavlov and Guorguiev, 1950: 107 - 118), on domestic fowls (Markov, 1916: 313 - 335). Jugoslavia - on poultry (Oswald, 1937: 265 - 273). Rumania - on domestic fowls (Markov, 1916: 313 - 335). Serbia - on domestic fowls (Markov, 1916: 313 - 335).

Asia

Asia - southern part (Olenev, 1931: 126 - 139). Baluchistan - (Neumann, 1911: 121). China - Peking (Neumann, 1911: 121). Iran - (Nuttall, et al., 1908: 8 - 22; Neumann, 1911: 121), on man (Harold, 1920: 484 - 498), domestic animals (Aluimov, 1936: 54 - 67). Turkey - domestic fowls (Markov, 1916: 313 - 335).

U. S. S. R.

U. S. S. R. - (Olenev, 1926: 13 - 14); southern part (Olenev, 1927: 219 - 224), on chickens, ducks, geese, man (Olenev, 1931: 3 - 125). Armenian S. S. R. - in valley of Arax River, in hen houses (Pomerantzev, 1934: 63 - 66). Kazakh S. S. R. - (Olenev, 1929: 25 pp.; Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139), on chickens and ducks (Olenev, 1930: 604 - 610); western part (Zasukhin, 1933: 31 - 46); southern part, on fowl (Tzelishcheva, 1941: 34 - 36). R. S. F. S. R. - (Neumann, 1911: 121; Olenev, 1934: 367 - 388); southern part (Olenev, 1927: 546 - 549), on domestic fowl (Yakimov, 1922: 41 - 46); central part (Olenev, 1927: 546 - 549); Saratov Province (Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Zasukhin, 1933: 31 - 46), in poultry houses (Martini, 1928: 1 - 134; Olenev, 1934: 367 - 388), on chickens, geese, ducks, man (Olenev, 1931: 3 - 125; Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159); Ozink (Zasukhin, 1933: 31 - 46); Stalingrad Province (Zasukhin, 1933: 31 - 46); Kamyshin (Zasukhin, 1933: 31 - 46). Turkmen S. S. R. - (Olenev, 1929: 305 - 314); Murghab Valley, on fowl (Popov and Lototzky, 1932: 211 - 233). Uzbek S. S. R. - on fowl (Moskvin, 1927: 375 - 380); Bukhara Province (Olenev, 1929: 305 - 314). Crimean A. S. S. R. - (Olenev, 1931: 126 - 139). Stavropol Territory - Pyatigorsk, on fowl (Yakimov and Rastegaeva, 1929: 764 - 765; Yakimov and Rastegaeva, 1930: 223 - 240; Rastegaeva and Kolabsky, 1940: 408 - 410). Caucasia - (Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139), on geese (Marzinovsky, 1914:

714 - 735). Central Asia - (Korovnikov, 1926: 81 - 86; Sofiev, 1930: 43 - 46; Olenev, 1931: 126 - 139). Turkestan - (Neumann, 1911: 121), on domestic fowl (Yakimov, et al., 1916: 227 - 228; Yakimov, 1917: 298 - 301).

Biology

Life cycle: Oviposition was not observed at temperatures of 14 to 18° C., but it occurred after 5 to 16 days at 24 to 28° C. Development only proceeded at temperatures above 20° C. and exposure to a high degree of humidity was detrimental (Olenev, 1926: 13 - 14). Adults resisted starvation for about three years (Skrynnik, 1948: 265 - 274).

Seasonal activity: This species was active in the summer (Nuttall, et al., 1908: 8 - 22) and very hot weather was favorable for its development (Yakimov and Rastegaeva, 1929: 764 - 765).

Habitats: All stages were found in poultry houses and in poultry yards (Olenev, 1934: 367 - 388; Pomerantzev, 1934: 63 - 66; Yakimov, et al., 1916: 227 - 228; Martini, 1928: 1 - 134; Olenev, 1930: 604 - 610; Sadovsky, 1932: 20 - 26). The dry steppe zone and the semi-desert zone were preferred habitats (Zasukhin, 1933: 31 - 46; Zasukhin, 1935: 1 - 159).

Control Measures

Effective control of ticks in poultry houses was obtained by painting or spraying with crude oil, either alone or mixed with an equal proportion of kerosene. Treatment should be repeated, if necessary, after 20 to 30 days (Olenev, 1927: 546 - 549). Good results were also obtained by the application of used lubricating oil, either alone or emulsified with clay or ox bile (Bernadskaya, 1944: 44). In tests with pulped leaves of Prunus laurocerosus the adults and nymphs were paralyzed in 10 minutes and died in 2 to 48 hours (Olenev, 1950: 1119 - 1120).

Dusts of 5% BHC and DDT were tested against adults and eggs. When applied to adults in jars BHC killed a large proportion of males and unfed females and immobilized the rest in 24 hours. It killed the partly engorged females in 2 to 5 days and the fully engorged females in 6 to 15 days. None of the dusted females oviposited. DDT killed the unengorged females in 24 hours, the partly engorged females in 3 to 5 days and the engorged females in 10 - 15 days. When females were dusted immediately after having engorged, it was found that all those

treated with BHC died within 24 - 28 hours whereas 80 to 90% of those dusted with DDT survived (Pavlov and Guorguiev, 1950: 107 - 118). A 5% concentration of DDT and BHC also killed larvae and nymphs (Nikolsky, 1948: 29 - 33).

Relation to Disease

Spirochaetosis - A. persicus was regarded as a vector of spirochaetosis to poultry (Marzinovsky, 1914: 714 - 735; Yakimov, et al., 1916: 227 - 228; Markov, 1916: 313 - 335; Yakimov, 1922: 41 - 46; Yakimov and Rastegaeva, 1929: 764 - 765; Yakimov and Rastegaeva, 1930: 223 - 240; Olenev, 1931: 3 - 125; Sadovsky, 1932: 20 - 26; Oswald, 1937: 265 - 273; Tzelishcheva, 1941: 34 - 36; Rastegaeva and Kolabsky, 1940: 408 - 410) and it also transmitted Aegyptianella pullorum (Oswald, 1937: 265 - 273).

Spirochaetosis appeared in fowl 4 to 7 days after exposure to infected Argas persicus and 2 to 4 days after intra-muscular inoculation with infected blood. Young ducks were infected 3 days after inoculation. Pigeons were neither infected by Argas nor by inoculation (Yakimov and Rastegaeva, 1930: 223 - 240). Argas persicus naturally infected with Spirochaeta anserina transmitted spirochaetosis to fowl for 8 years after the original infective feeding (Rastegaeva and Kolabsky, 1940: 408 - 410).

Relapsing Fever - Attempts to transmit the spirochaetes of relapsing fever to man, guinea pigs and rats by the bite of ticks fed 19 to 35 days previously on artificially infected guinea pigs were negative but spirochaetes were present in the intestinal tract and in the body fluids of the ticks dissected 37, 70 and 84 days after the infective feeding. Spirochaetes were also found in a guinea pig on the tenth day after the injection of an emulsion prepared from the intestinal contents of five ticks which had fed on infected guinea pigs 36 days previously (Sofiev, 1930: 43 - 46).

Plague - Of 49 ticks fed on a guinea pig infected with Bacillus pestis 18, 12 and 6 hours before death and during agony when bacteriemia is most pronounced, 5, 6, 10, 21, 28 and 110 days later 11 ticks or 23.6% were still infected. Of the ticks fed 18 days before death when the bacteriemia was slight 12.5% were still infected. In three cases dead ticks preserved the bacilli up to 8 days. Saline emulsions of infected ticks injected into mice intraperitoneally killed the mice in 2 to 3 days and plague cultures were obtained from emulsified organs. One of the ticks which preserved the infection for 110 days passed from the nymphal to the adult stage indicating that

the infection may be maintained from stage to stage (Faddeeva, 1932: 273 - 279).

Argas reflexus (Fabricius)

Acarus reflexus Fabricius, 1794: 426; Fabricius, 1805: 353.
Argas reflexus, Latreille, 1796: 178; Latreille, 1829: 288; Nuttall, et al., 1908: 22 - 27; 91 - 95; Neumann, 1911: 119; Yakimov, 1917: 298 - 301; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev, 1934: 367 - 388; Karpov and Popov, 1944: 75 - 79).

Localities and Hosts

Europe

Austria - (Olenev, 1934: 367 - 388). Bulgaria - (Olenev, 1934: 367 - 388). Rumania - (Olenev, 1931: 126 - 139), on horse (Nuttall, et al., 1908: 22 - 27; Neumann, 1911: 119).

Asia

China - Khorgas, on man (Olenev, 1934: 367 - 388).

U. S. S. R.

R. S. F. S. R. - (Neumann, 1911: 119; Yakimov, 1917: 298 - 301); Novosibirsk Province (Karpov and Popov, 1944: 75 - 79). Tadzhik S. S. R. - Pamir Mountains (Olenev, 1929: 305 - 314). Ukrainian S. S. R. - Odessa Province: Odessa (Nuttall, et al., 1908: 22 - 27). Uzbek S. S. R. - Bukhara Province: Bukhara (Olenev, 1929: 305 - 314). Crimean A. S. S. R. - (Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139). Krasnoyarsk Territory - Minusinsk, Lake Shiro (Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev, 1934: 367 - 388). Caucasia - (Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139). Central Asia - (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139). On following hosts without definite indication of locality: man, dove (Olenev, 1931: 3 - 125; Olenev, 1934: 367 - 388), chicken, geese (Olenev, 1931: 3 - 125).

Relation to Disease

A. reflexus was regarded as a vector of spirochaetosis to doves and chickens (Olenev, 1931: 3 - 125).

Argas vespertilionis (Latreille)

Carios vespertilionis Latreille, 1796: 176.
Argas vespertilionis, Neumann, 1896: 20 - 23; Neumann, 1901: 254; Nuttall, et al., 1908: 34 - 39; Neumann, 1911: 120; Olenev, 1929: 305 - 314; Olenev, 1930: 604 - 610; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Olenev, 1934: 367 - 388; Zasukhin, 1935: 1 - 159; Karpov and Popov, 1944: 75 - 79.
Argas pipistrellae Audouin, 1832: 412; Hoeppli and Feng, 1933: 29 - 43; Olenev, 1934: 367 - 388.

Localities and Hosts

Europe

Europe - (Olenev, 1931: 126 - 139). Germany, on bats (Neumann, 1911: 120).

Asia

Asia - (Olenev, 1931: 126 - 139). China - (Hoeppli and Feng, 1931: 29 - 43); Peking (Olenev, 1934: 367 - 388).

U. S. S. R.

U. S. S. R. - Black Sea Shore (Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125); Aulie Ata (Olenev, 1934: 367 - 388). Kazakh S. S. R. - southeastern part, on bat (Olenev, 1930: 604 - 610); Dzhambul Province: Novotroitskoe, on bats (Olenev, 1934: 367 - 388). R. S. F. S. R. - Novosibirsk Province (Karpov and Popov, 1944: 75 - 79); Stalingrad Province: near Lake Elton, on bat (Zasukhin, 1935: 1 - 159). Crimean A. S. S. R. - (Olenev, 1929: 305 - 314; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125). Caucasia - (Olenev, 1931: 126 - 139). Central Asia - (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125). Turkestan - (Olenev, 1929: 305 - 314). On following hosts without definite indica-

tion of locality: on bats (Nuttall, et al., 1908: 34 - 39), in bat caves (Olenev, 1931: 3 - 125).

Biology

This species showed a preference for various species of bats and it was found only on bats and in caves where bats occurred.

Ornithodoros alactagalis Pospelova-Shtrom

Ornithodoros alactagalis Pospelova-Shtrom, 1941: 96 - 100.

Little information was available for this species and it was stated that it would be described more fully; however, it was apparently a nomen nudum.

Ornithodoros canestrinii (Birula)

Argas canestrinii Birula, 1895: 353.
Ornithodoros canestrinii, Nuttall, et al., 1908: 78 - 79; Neumann, 1911: 124 - 125; Yakimov, 1917: 298 - 301; Korovnikov, 1926: 81 - 86; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Olenev, 1934: 367 - 388; Brumpt, 1935: 51 - 53; Popov and Akhundov, 1940: 255 - 259; Pavlovsky, 1948: 179 - 202; Pavlovsky and Skrynnik, 1951: 1069 - 1072.

Localities and Hosts

Iran - (Neumann, 1911: 124 - 125), in quarters of sheep and cattle (Pavlovsky, 1948: 179 - 202); northern part (Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139); Teheran (Nuttall, et al., 1908: 78 - 79; Olenev, 1934: 367 - 388); Ispahan (Brumpt, 1935: 51 - 53). U. S. S. R. - (Yakimov, 1917: 298 - 301). Azerbaijan S. S. R. - (Popov and Akhundov, 1940: 255 - 259). Caucasia - (Neumann, 1911: 124 - 125; Olenev, 1929: 305 - 314; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139); Tash-Burun (Nuttall, et al., 1908: 78 - 79; Olenev, 1934: 367 - 388). Turkestan - (Olenev, 1929: 305 - 314).

Biology

O. canestrinii was found in a number of places in quarters occupied by sheep or cattle and was particularly abundant in cracks among the stones of the walls of an unused enclosure for sheep. This abandoned sheep enclosure was in a bare site exposed to the sun, which indicated the ability of the ticks to survive under very unfavorable conditions. No infection in guinea pigs resulted from the feeding of adults and none occurred in guinea pigs from adults fed 1 - 5 months previously on infected guinea pigs or from second stage nymphs fed as larvae on infected rabbits over 13 months before (Pavlovsky, 1948: 179 - 202). This species survived without feeding for 6 years (Pavlovsky and Skrynnik, 1951: 1069 - 1072).

Ornithodoros cholodkovskii Pavlovsky

Ornithodoros cholodkovskii Pavlovsky, 1929: 84 - 122; Olenev, 1929: 305 - 314; Pavlovsky, 1930: 355 - 360; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Pospelova-Shtrom, 1946: 55 - 59; Pavlovsky and Lototzky, 1948: 125 - 146.

Localities and Hosts

Turkmen S. S. R. - southern part in caves inhabited by bats, chiefly Rhinolophus bocharicus, and also attacked man (Pospelova-Shtrom, 1946: 55 - 59). Uzbek S. S. R. - (Olenev, 1931: 3 - 125; Pavlovsky and Lototzky, 1948: 125 - 146). Central Asia - (Olenev, 1929: 305 - 314; Pavlovsky, 1929: 84 - 122; Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125). Turkestan - (Olenev, 1929: 305 - 314; Pavlovsky, 1930: 355 - 360).

Biology

Nymphs and adults were found in two extensive caves in southern Turkmen in 1935 and again in August, 1940. The caves were at an altitude of about 1400 and 1600 feet and the temperature in the caves varied from 24 - 27° C. One of these caves was inhabited by bats, chiefly Rhinolophus bocharicus and the ticks were found in the parts of the cave actually occupied by the bats. Ticks collected in these

areas were engorged or contained partially digested blood. Workers who spent several hours on the floor of the cave searching for ticks were not attacked by them. The ticks were found in cracks and in depressions in the wall and they were common near the floor of the cave and in droppings of the bats as well as in other debris. In another cave only a single bat was found and the tick population was not large. They apparently survived by feeding on occasional hosts which entered the cave. These ticks were found throughout the parts of the cave studied and consisted of partially engorged or unfed forms. These forms readily attacked man.

Though no relapsing fever spirochaetes were isolated from the bats in these caves, they were found by Latuishev in bats taken from one of these caves in 1934 and by Pospelova-Shtrom in 1940. Two workers contracted the disease in 1935 after having visited the cave and this species must have been the vector since no other ectoparasites occurred on the bats (Pospelova-Shtrom, 1946: 55 - 59).

Ornithodoros lahorensis Neumann

Ornithodoros lahorensis Neumann, 1908: 17; Nuttall, et al., 1908: 67 - 69; Neumann, 1911: 124; Harold, 1920: 484 - 498; Junkovski, 1927: 56 - 66; Marzinovsky, 1927: 314 - 318; Moskvin, 1927: 375 - 380; Troitzky, 1928: 275 - 276; Pavlovsky, 1929: 84 - 122; Sofiev, 1929: 18 - 21; Moskvin, 1929: 128 - 130; Olenev, 1930: 604 - 610; Khodukin and Sofiev, 1931: 283 - 285; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pavlovsky, 23 - 34; Khodukin and Sofiev, 1932: 63 - 65; Olenev and Kastrov, 1932: 28 - 30; Pavlovsky, 1932: 79 - 100; Pavlovsky and Pomerantzev, 1934: 49 - 62; Olenev, 1934: 367 - 388; Pomerantzev, 1934: 63 - 66; Klimentova and Perfilev, 1935: 71 - 88; Olenev, 1935: 133 - 135; Rastegaeva, 1935: 250 - 258; Rastegaeva, 1936: 732 - 733; Rastegaeva, 1936: 730 - 732; Popov and Akhundov, 1936: 289 - 295; Pavlovsky, 1936: 13 - 43; Brumpt, 1936: 632 - 639; Aluimov, 1936: 54 - 67; Pirumov, 1937: 756 - 770; Moskvin, 1939: 93 - 103; Delpy and Rafyi, 1939: 45 - 61; Popov and Akhundov, 1940: 255 - 259; Rastegaeva, 1940: 29 - 30; Tzelishcheva, 1941: 34 - 36; Pavlov, 1944: 177 - 182; Pavlovsky, 1944: 1 - 79; Bernadskaya, 1944: 44; Pavlovsky and Kuzmina, 1945: 66 - 70; Gutsevich, 1948: 536 - 564; Pavlovsky, 1948: 179 - 202; Skrynnik, 1948: 265 - 274; Shustrov, 1951: 393 - 397; Pavlovsky and Skrynnik, 1951: 1069 - 1072.

NOT Ornithodoros lahorensis, Latuishev, 1926: 21 pp.; Korovnikov, 1926: 81 - 86 (= O. tholozani).

Localities and Hosts

Europe

Jugoslavia - near Monastir, on sheep (Pavlov, 1944: 177 - 182); Bitol, in southern Macedonia (Gutsevich, 1948: 563 - 564).

Asia

Asia Minor - on domestic animals (Brumpt, 1936: 632 - 639). Iran - (Olenev, 1931: 126 - 139; Pavlovsky, 1932: 79 - 100; Aluimov, 1936: 54 - 57; Delpy and Rafyi, 1939: 45 - 61), on man (Harold, 1920: 484 - 498), camels (Pavlovsky and Pomerantzev, 1934: 49 - 62; Pavlovsky, 1948: 179 - 202), cattle, sheep, goats (Pavlovsky, 1948: 179 - 202), domestic animals (Brumpt, 1936: 632 - 639). Tibet - on domestic animals (Brumpt, 1936: 632 - 639).

U. S. S. R.

Armenian S. S. R. - (Pavlovsky, 1932: 79 - 100), in cattle sheds (Pirumov, 1937: 756 - 770); in villages in the valley of the Arax River, in houses and in animal quarters (Pomerantzev, 1934: 63 - 66).

Azerbaijan S. S. R. - (Popov and Akhundov, 1940: 255 - 259), on sheep (Rastegaeva, 1935: 250 - 258); Baku, in stone walls of old caravenserai used as shelter for sheep, camels and horses (Popov and Akhundov, 1936: 289 - 295).

R. S. F. S. R. - Grozny Province: Kizlyar (Olenev, 1934: 367 - 388), on cattle (Olenev and Kastrov, 1932: 28 - 30); Rostov Province: Taganrog on sheep (Olenev, 1934: 367 - 388).

Kazakh S. S. R. - southern part (Olenev, 1930: 604 - 610; Olenev, 1931: 3 - 125; Olenev and Kastrov, 1932: 28 - 30) on sheep (Tzelishcheva, 1941: 34 - 36); Taldy Kurgan Province: Konur Ulen, Katu-tau Mountains (Olenev, 1934: 367 - 388), in sheep folds (Olenev, 1935: 133 - 135).

Kirghiz S. S. R. - western part, in a living room in a town (Pavlovsky, 1931: 23 - 34).

Tadzhik S. S. R. - (Olenev, 1931: 3 - 125); Kharkaron, in cattle yard; Darob, in barn (Pavlovsky, 1936: 13 - 43); western Pamir Mountains, in dwellings and in animal quarters (Moskvin, 1939: 93 - 103);

Stalinabad Province: Ramit, in cattle barn; Jangi (Pavlovsky, 1929: 84 - 122).

Turkmen S. S. R. - (Olenev, 1931: 3 - 125; Pavlovsky and Kuzmina, 1945: 66 - 70), on camels (Pavlovsky and Pomerantzev, 1934: 49 - 62), domestic animals (Brumpt, 1936: 632 - 639); Chardzhou Province: Kerki (Pavlovsky, 1929: 84 - 122); Askkhabad Province: Ashkhabad, on camels (Pavlovsky, 1932: 79 - 100).

Uzbek S. S. R. - (Olenev, 1931: 3 - 125); Khodzhent, on sheep; Khanabad, on sheep; Dragomirova, on sheep; Sokelevo St., on sheep; Ten Tiaksai, in horse stable; Niazbek, on cattle; Bogantdin, on cattle (Pavlovsky, 1929: 84 - 122); eastern part (Pavlovsky, 1932: 79 - 100), villages: Airitan, on sheep; Fungan, on sheep; Digana , on sheep; Aschtsch, on sheep;Kiarim-divana, in stable; Akdzhor, on sheep; Gandzhirovan, on sheep; Buvaida, on sheep; Okhul, on sheep; Ak-Tepe, on sheep; Dakhana, on sheep; Kirikuduk; Anganbak, on cattle; K. Nauman, on sheep; Gandzhirovan, on sheep; Kuinar, on sheep (Pavlovsky, 1931: 23 - 34); Tashkent Province: Tashkent, on cattle (Sofiev, 1929: 18 - 21; Pavlovsky, 1929: 84 - 122), sheep (Sofiev, 1929: 18 - 21), dogs, camels, goats; Chirtchik, on cattle (Pavlovsky, 1929: 84 - 122); Fergana Province: Fergana (Moskvin, 1929: 128 - 130; Pavlovsky, 1929: 84 - 122); Kokand on sheep, in cattle stall; Serovo St.; Baytok St., on sheep (Pavlovsky, 1929: 84 - 122); Andizhan Province: Andizhan, on sheep (Pavlovsky, 1929: 84 - 122; Sofiev, 1929: 18 - 21), on cattle (Sofiev, 1929: 18 - 21); Samarkand Province: Katta-Kurgan, on small horned animals (Pavlovsky, 1929: 84 - 122); Bukhara Province: Bukhara, on sheep, cattle (Sofiev, 1929: 18 - 21; Pavlovsky, 1929: 84 - 122), goats, donkey, dog (Pavlovsky, 1929: 84 - 122); villages, Giltanap, on sheep; Bedodak, on sheep and camels; Tovarion, on sheep; Liliak, on sheep; Gansdushak, on sheep; Schirabad, on sheep; Bukhara St.; Kaskha Dar-Inskaya Province: Guzar, on sheep and inside house (Pavlovsky, 1929: 84 - 122).

Central Asia - (Marzinovsky, 1927: 314 - 318; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Khodukin and Sofiev, 1932: 63 - 65; Olenev and Kastrov, 1932: 28 - 30; Pavlovsky, 1932: 79 - 100; Pavlovsky, 1944: 1 - 79), on domestic animals (Pavlovsky and Pomerantzev, 1934: 49 - 62; Brumpt, 1936: 632 - 639).

Transcaucasia - (Olenev, 1931: 126 - 139; Olenev and Kastrov, 1932: 28 - 30; Pavlovsky and Kuzmina, 1945: 66 - 70), on domestic animals (Brumpt, 1936: 632 - 639).

On following hosts without definite indication of locality: man, camel, cattle, sheep, goat, dog, donkey (Olenev, 1931: 3 - 125).

Biology

Life history: This species was reared in the laboratory on sheep but not on dogs or guinea pigs. The larval stage, the first two nymphal stages and part of the third nymphal stage were spent on the same host (Brumpt, 1936: 632 - 639). The engorged third nymphal stage dropped to the ground after feeding (Brumpt, 1936: 632 - 639; Rastegaeva, 1940: 29 - 30) and gave rise to the adult stage. After feeding and pairing each female laid between 200 and 560 eggs. The cycle from egg to egg lasted about 108 days (Brumpt, 1936: 632 - 639). Apparently the third nymphal stage overwintered on animals (Brumpt, 1936: 632 - 639; Pavlovsky and Pomerantzev, 1934: 49 - 62). Adults survived for as long as 8 years without food (Pavlovsky and Skrynnik, 1951: 1069 - 1072) and some females which resisted starvation for about 3 years laid viable eggs after feeding (Skrynnik, 1948: 265 - 274).

Seasonal activity: In eastern Uzbek the maximum activity and findings were in February, March and April (Pavlovsky, 1929: 84 - 122). In Tadzhik and Uzbek all stages were active in December, January and February (Sofiev, 1929: 18 - 21). In southeastern Kazakh they were almost abundant from the beginning of December to the end of March (Olenev, 1935: 133 - 135).

Habitats: All stages were found in cracks and crevices of wooden and stone structures used as shelter for domestic animals (Rastegaeva, 1935: 250 - 258; Popov and Akhundov, 1936: 289 - 295; Pavlovsky, 1936: 13 - 43) and they occurred in the desert and semi-desert zones (Olenev, 1931: 3 - 125).

Control Measures

Mortality of sheep due to a disease apparently transmitted by Ornithodoros lahorensis was reduced considerably by the application of various dressings by hand (Olenev, 1935: 133 - 135). Good results were obtained with the application of used lubricating oil either alone or emulsified with clay or ox bile (Bernadskaya, 1944: 44).

Relation to Disease

Relapsing Fever - O. lahorensis was a suspected vector of tick-borne relapsing fever (Latuishev, 1926: 21 pp.; Korovnikov, 1926: 81 - 86; Troitzky, 1928: 275 - 276) but it was later proven incapable of

transmitting Spirochaeta sogdiana (Pavlovsky, 1932: 79 - 100; Aluimov, 1936: 54 - 67; Pirumov, 1937: 756 - 770; Delpy and Rafyi, 1939: 45 - 61; Pavlovsky, 1944: 1 - 79; Pavlovsky and Kuzmina, 1945: 66 - 70; Gutsevich, 1948: 563 - 564; Pavlovsky, 1948: 179 - 202). Even though it did not transmit Spirochaeta sogdiana it was experimentally infected. The spirochaetes persisted in the ticks for as long as 80 days, though in no stage was this tick infective by its bite. Inoculation of guinea pigs with coxal fluid also gave negative results. Experiments to determine whether the spirochaetes could be transmitted through the egg were negative (Khodukin and Sofiev, 1932: 63 - 65).

Epidemic Typhus - O. lahorensis experimentally transmitted the rickettsiae of epidemic typhus both by bites and by an injection of an emulsion of ticks. The rickettsiae were preserved in the ticks for up to 25 days and were then transmitted by biting. It appeared that the rickettsiae gradually weakened in the tick as evidenced by a prolongation of the incubation period in guinea pigs (Klimentova and Perfilev, 1935: 71 - 88).

Tularemia and Brucellosis: Ornithodoros lahorensis was a suspected vector of tularemia and brucellosis (Pavlovsky, 1944: 1 - 79).

Anaplasmosis and Piroplasmosis: A disease was transmitted to sheep by O. lahorensis that was often fatal (Rastegaeva, 1935: 250 - 258; Olenev and Kastrov, 1932: 28 - 30; Olenev, 1935: 133 - 135) and as many as 50% of the sheep in some folds died in the winter of 1930-31 (Olenev, 1935: 133 - 135). Sheep were not infected in the summer (Sofiev, 1929: 18 - 21). The disease was reported to be absent for 2 years from newly constructed shelters but mortality occurred in the third year. When nymphs and adults were allowed to feed on a healthy kid it died some weeks later after Anaplasma ovis and Theileria species had been found in its blood (Rastegaeva, 1935: 250 - 258). O. lahorensis was considered to be a vector of T. ovis and A. ovis to sheep (Rastegaeva, 1936: 732 - 733).

Tick Paralysis: Ornithodoros lahorensis caused paralysis in sheep (Rastegaeva, 1936: 730 - 732; Rastegaeva, 1940: 29 - 30; Tzelishcheva, 1941: 34 - 36). The paralysis appeared in sheep 21 - 23 days after larvae had been placed on them and this period corresponded to the time it took the larvae to reach the nymphal stage. Paralysis occurred when the infestation was heavy; only a slight paralysis appeared when successive single individuals were fed; and not at all when only a single tick fed. In similar tests with third stage nymphs and adults the paralysis occurred in 9 days by mass feeding but did not occur as the result of feeding by single individuals. Sheep which were still able to swallow sometimes recovered when the ticks were re-

moved. Feeding by third stage nymphs and adults on dogs caused paralysis in 23 days. Injections into healthy dogs of blood and a suspension of organs from dogs showing paralysis had no effect within a similar period. The paralysis was thought to be due to a toxin injected by ticks in the process of feeding and the effects depend upon the amount of toxin injected and the degree of proximity of the ticks to the head and to the spinal cord. Paralysis and death apparently resulted from disturbances of brain functions (Rastegaeva, 1940: 29 - 30).

Ornithodoros nereensis Pavlovsky

Ornithodoros nereensis Pavlovsky, 1941: 408 - 410; Pospelova-Shtrom, 1941: 145 - 152; Pospelova-Shtrom, 1941: 96 - 100; Pavlovsky, 1944: 1 - 79; Pavlovsky, 1945: 56 - 59; Pavlovsky and Lototzky, 1948: 125 - 146.

Localities and Hosts

Turkmen S. S. R. - (Pospelova-Shtrom, 1941: 96 - 100; Pavlovsky, 1945: 56 - 59); Ashkhabad Province: Kara-Kala region on reptiles and small mammals (Pavlovsky, 1944: 1 - 79), in burrows (Pavlovsky and Lototzky, 1948: 125 - 146; Pospelova-Shtrom, 1941: 145 - 152) of mammals, reptiles or birds (Pavlovsky, 1941: 408 - 410).

Biology

Habitats: All stages were found under stones (Pavlovsky, 1941: 408 - 410; Pavlovsky and Lototzky, 1948: 125 - 146), in crevices in walls of huts (Pavlovsky, 1941: 408 - 410), in burrows of animals (Pavlovsky, 1941: 408 - 410; Pospelova-Shtrom, 1941: 145 - 152; Pavlovsky and Lototzky, 1948: 125 - 146). The occurred in the cultivated irrigated zone and in the undulating foothills but were more abundant in fairly damp lands at the foot of the mountain steppe zones at an altitude of 1650 - 4600 feet. They were also found in the front part of burrows where the temperature was almost always 27° C. Excessive humidity appeared detrimental as the ticks left the front part of the burrows after heavy rains (Pospelova-Shtrom, 1941: 145 - 152). None were found in human edifices (Pavlovsky, 1944: 1 - 79).

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Relation to Disease

Relapsing Fever: Though an earlier attempt to transmit spirochaetes failed, later experiments on the treatment of progressive paralysis by induced relapsing fever resulted in the transmission of spirochaetes to man and mice (Pavlovsky, 1941: 408 - 410). Ticks were also found in nature infected with spirochaetes (Pavlovsky, 1944: 1 - 79) and this species was regarded as a vector of relapsing fever (Pavlovsky, 1941: 408 - 410; Pavlovsky, 1945: 56 - 59).

Ornithodoros tartakovskyi Olenev

Ornithodoros tartakovskyi Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125; Pavlovsky, 1934: 29 - 47; Zasukhin, et al., 1934: 635 - 638; Pavlovsky, 1939: 11 - 23; Pospelova-Shtrom, 1940: 618 - 622; Mironov, et al., 1940: 106 - 108; Pospelova-Shtrom, 1941: 96 - 100; Sofiev, 1941: 267 - 271; Pospelova-Shtrom, 1941: 145 - 152; Pospelova-Shtrom and Tiburskaya, 1943: 85 - 86; Pavlovsky, 1943: 286 - 288; Pavlovsky, 1944: 1 - 79; Pavlovsky, 1945: 56 - 59; Pavlovsky and Lototzky, 1948: 125 - 146; Sofiev and Leonova, 1948: 265 - 268; Pavlovsky and Skrynnik, 1948: 255 - 264; Pavlovsky and Skrynnik, 1951: 1069 - 1072.

Localities and Hosts

Kazakh S. S. R. - Guryev Province: Mangyshlak Peninsula, in burrows of rodents, tortoises, hedgehog, Rhombomys opimus and on man (Pavlovsky, 1939: 11 - 23; Pavlovsky and Lototzky, 1948: 125 - 146); southwestern part (Pavlovsky and Skrynnik, 1948: 255 - 264). R. S. F. S. R. - southeastern part on Rhombomys opimus (Zasukhin, et al., 1934: 635 - 638). Tadzhikh S. S. R. - southern part, in burrows and in nests of rodents and turtles (Pavlovsky and Lototzky, 1948: 125 - 146). Turkmen S. S. R. - (Pavlovsky, 1945: 56 - 59); southern part, in burrows of Rhombomys opimus (Sofiev, 1941: 267 - 271); southern and southwestern parts, in burrows of Rhombomys opimus and Spermophilopsis leptodactylus (Pospelova-Shtrom, 1941: 145 - 152), in burrows and in nests of rodents and tortoises (Pavlovsky and Lototzky, 1948: 125 - 146); Ashkhabad Province: near Ashkhabad (Pavlovsky, 1944: 1 - 79), in burrows of rodents (Pavlovsky, 1934: 29 - 47), in burrows of hedgehogs (Pospelova-Shtrom, 1940: 618 - 622); Mary Prov-

ince: Sandi-Katschi, in Iolotan District, in nests of Rhombomys opimus (Sofiev and Leonova, 1948: 265 - 268). Uzbek S. S. R. - on Testudo species (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125); eastern part, in burrows of Gerbillus eversmanni (Sofiev, 1941: 267 - 271); Fergana Province: Fergana, on domestic mice (Gerbillus eversmanni and dogs (Sofiev and Leonova, 1948: 265 - 268). Central Asia - (Pavlovsky, 1943: 286 - 288).

Biology

Life history: O. tartakovskyi was short lived in comparison to other species of the genus (Pospelova-Shtrom, 1941: 96 - 100); but it lived without food for 4 years (Pavlovsky and Skrynnik, 1951: 1069 - 1072). A temperature of 27° C. appeared to be the optimum in nature and it was also found to be the optimum temperature for oviposition and hatching in the laboratory (Pospelova-Shtrom, 1941: 145 - 152).

Habitat: All stages were found near the mountain semi-desert zone (Olenev, 1931: 126 - 139; Olenev, 1931: 3 - 125), in the desert steppe zone (Pospelova-Shtrom, 1940: 618 - 622; Pospelova-Shtrom, 1941: 96 - 100) and in the semi-desert zone (Pospelova-Shtrom, 1941: 96 - 100). Though they were comparatively rare in the desert plain they were abundant in dry waste land, in ravines, in cemeteries in the cultivated zones of river valleys and in the undulating foothills of a desert steppe character. In the summer the ticks congregated in the front part of the burrows where the temperature was almost always 27° C. Excessive humidity was unfavorable and the ticks left the front part of the burrows after heavy rains (Pospelova-Shtrom, 1941: 145 - 152).

Control Measures

Imported derris root was of no value as a control measure (Mironov, 1940: 106 - 108).

Relation to Disease

Relapsing Fever: This species was a natural and an experimental vector of relapsing fever (Pospelova-Shtrom, 1940: 618 - 622; Pospelova-Shtrom and Tiburskaya, 1943: 85 - 86; Sofiev, 1941: 267 -

271; Pavlovsky, 1941: 1 - 79; Pavlovsky, 1945: 56 - 59; Sofiev and Leonova, 1948: 265 - 268). Four strains of spirochaetes were isolated from Rhombomys opimus, Gerbillus eversmanni and from Ornithodoros tartakovskyi. These strains were not pathogenic to guinea pigs, rats and dogs and they caused only a short lived infection in mice and rabbits. Naturally infected nymphs and males which were infective to mice fed only reluctantly on man and the disease was transmitted in only 1 case out of 6. All four strains, however, were readily transmissible to man by inoculation of infected blood and were about equally pathogenic. These strains were regarded as distinct from Spirochaeta persica and were considered to be a new species, S. latyschewi (Sofiev, 1941: 267 - 271). The reservoirs of this disease were domestic mice, Gerbillus eversmanni and dogs (Sofiev and Leonova, 1948: 265 - 285). Rhombomys opimus which was often associated with O. tartakovskyi and probably served as a reservoir for this strain of spirochaetes in nature (Pospelova-Shtrom, 1940: 618 - 622).

Ornithodoros tholozani (Laboulbène and Mégnin)

Argas tholozani Laboulbène and Mégnin, 1882: 335 - 337; Neumann, 1896: 38.

Ornithodoros tholozani, Nuttall, et al., 1908: 65 - 66, 103; Neumann, 1911: 125; Marzinovsky, 1914: 714 - 735; Yakimov, 1917: 298 - 301; Yakimov, 1922: 41 - 46; Junkovsky, 1927: 56 - 66; Marzinovsky, 1927: 314 - 318; Pavlovsky and Shtein, 1927: 401 - 408; Pavlovsky and Shtein, 1927: 31 - 37; Lauishev, 1927: 12 pp.; Moskvin, 1927: 375 - 380; Troitzky, 1928: 275 - 276; Pavlovsky, 1928: 5 - 11; Moskvin, 1929: 208 - 213; Olenev, 1929: 305 - 314; Aluimov, 1936: 54 - 67; Pavlovsky and Aluimov, 1939: 72 - 98; Pospelova-Shtrom, 1941: 145 - 152; Desportes and Campana, 1946: 74 - 88; Delpy and Rafyi, 1946: 62 - 63.

Ornithodoros papillipes Birula, 1895: 354; Nuttall, et al., 1908: 79 - 80; Moskvin, 1927: 375 - 380; Pavlovsky and Shtein, 1927: 401 - 408; Pavlovsky and Shtein, 1927: 31 - 37; Nicolle and Anderson, 1928: 746 - 748; Pavlovsky, 1928: 5 - 11; Moskvin, 1929: 208 - 213; Sofiev, 1929: 18 - 21; Moskvin, 1929: 128 - 130; Pavlovsky, 1929: 84 - 122; Masaitis, 1929: 123 - 127; Olenev, 1929: 305 - 314; Pavlovsky and Khodukin, 1929: 90 - 96; Moskvin, 1929: 73 - 89; Pavlovsky, 1930: 355 - 360; Pavlovsky, 1931: 23 - 34; Khodukin and Sofiev, 1931: 50 - 55; Olenev, 1931: 3 - 125; Olenev,

1931: 126 - 139; Khodukin and Sofiev, 1931: 283 - 285; Pavlovsky, 1931: 73 - 84; Pavlovsky, 1932: 79 - 100; Kohdukin and Sofiev, 1932: 63 - 65; Pavlovsky, 1934: 29 - 47; Kandelaki, 1935: 65 - 66; Latuishev, 1936: 174 - 178; Aluimov, 1936: 54 - 67; Pavlovsky, 1936: 13 - 43; Pavlovsky and Shtein, 1936: 89 - 96; Popov and Akhundov, 1936: 289 - 295; Zasukhin, 1936: 457 - 460; Latuishev, 1937: 82 - 90; Moskvin, 1939: 93 - 103; Delpy and Rafyi, 1939: 45 - 61; Moskvin, 1939: 79 - 82; Serdyukova, 1939: 51 - 57; Pavlovsky, 1939: 19 - 35; Moskvin, 1939: 59 - 78; Pavlovsky and Skrynnik, 1939: 25 - 42; Belous, 1939: 237 - 250; Pavlovsky, 1939: 11 - 23; Pavlovsky and Shtein, 1939: 251 - 255; Skrynnik, 1939: 43 - 50; Pospelova-Shtrom, 1940: 618 - 622; Popov and Akhundov, 1940: 255 - 259; Sofiev, 1941: 267 - 271; Pospelova-Shtrom, 1941: 96 - 100; Naumov and Mesentseva, 1942: 118 - 119; Pavlovsky and Teravsky, 1942: 120 - 121; Pavlovsky, 1943: 286 - 288; Pavlovsky and Cheskis, 1943: 55 - 56; Pavlovsky, 1944: 1 - 79; Skopin, 1944: 110 - 115; Slavina, 1944: 85 - 87; Pavlovsky and Skrynnik, 1945: 161 - 164; Pavlovsky and Skrynnik, 1945: 277 - 294; Troitzky, 1945: 70 - 75; Troitzky, 1945: 75 - 79; Pisarenko and Sosnina, 1946: 101 - 108; Sosnina, 1946: 92 - 110; Desportes and Campana, 1946: 74 - 88; Pavlovsky and Skrynnik, 1948: 255 - 264; Pavlovsky, 1948: 179 - 202; Pavlovsky and Lototzky, 1948: 125 - 146; Sofiev and Leonova, 1948: 265 - 268; Skrynnik, 1948: 265 - 274; Sosnina, 1949: 380 - 382; Pavlovsky, 1950: 1 - 16; Pavlovsky and Skrynnik, 1951: 1069 - 1072.

Ornithodoros miana Starobynsky, 1922: 1445 - 1446.

Ornithodoros lahorensis, Latuishev, 1926: 21 pp.; Korovnikov, 1926: 81 - 86.

Localities and Hosts

Afghanistan - (Pavlovsky, 1944: 1 - 79). Iran - (Neumann, 1911: 125; Starobynsky, 1922: 1445 - 1446; Junkovsky, 1927: 56 - 66; Desportes and Campana, 1946: 74 - 88), on man (Delpy and Rafyi, 1946: 62 - 63; Pavlovsky, 1948: 179 - 202), in buildings (Aluimov, 1936: 54 - 67; Pavlovsky, 1948: 179 - 202), in caves (Pavlovsky, 1948: 179 - 202); Teheran (Pavlovsky and Shtein, 1939: 251 - 255), in poultry houses, on camels (Nuttall, et al., 1908: 65 - 66, 103; Pavlovsky, 1929: 84 - 122); Hessarek, on man (Delpy and Rafyi, 1939: 45 - 61). Iraq - Babylon (Desportes and Campana, 1946: 74 - 88). Syria - (Desportes and Campana, 1946: 74 - 88).

U. S. S. R. - (Yakimov, 1917: 298 - 301). Azerbaijan S. S. R. - (Popov and Akhundov, 1940: 255 - 259). Kazakh S. S. R. - southern part (Pavlovsky and Lototzky, 1948: 125 - 146); Yuzhno-Kazakh Province: Bostanduik District (Slavina, 1944: 85 - 87); restricted to valley of Chirchik River, in cattle sheds, houses, poultry houses, store rooms, uninhabited quarters, near burrows of rats and mice (Skopin, 1944: 110 - 115); Gazalkent, in house (Slavina, 1944: 85 - 87).

Kirghiz S. S. R. - southwestern part, in artificial caves where grain was stored or where sheep were kept in winter, in burrows of rodents and tortoises, in holes inhabited by birds, in houses, in burrows of porcupine and Meriones erythrourus (Pavlovsky and Aluimov, 1939: 72 - 98); southern part (Pavlovsky, 1939: 19 - 35; Pavlovsky, 1944: 1 - 79); western part, in house (Pavlovsky, 1931: 23 - 34); Osh Province: Osh (Pavlovsky, 1931: 23 - 34; Pavlovsky and Lototzky, 1948: 125 - 146); Kzyl-Kiya, in house, stable, cow shed and in caves (Naumov and Mesentseva, 1942: 118 - 119); Sulyukta (Pavlovsky and Lototzky, 1948: 125 - 146).

Tadzhikh S. S. R. - (Olenev, 1931: 3 - 125; Pavlovsky, 1939: 19 - 35; Pavlovsky, 1944: 1 - 79; Skrynnik, 1948: 265 - 274), in animal quarters (Sosnina, 1946: 92 - 110; Sosnina, 1949: 380 - 382); Sary Tschaschma (Pavlovsky, 1944: 1 - 79), in barns and stalls (Pavlovsky, 1936: 13 - 43); Tschubek (Pavlovsky, 1944: 1 - 79); western part, in cave (Latuishev, 1936: 174 - 178); along frontier (Pisarenko and Sosnina, 1946: 101 - 108); western Pamir Mountains (Pavlovsky and Lototzky, 1948: 125 - 146; Pavlovsky, 1944: 1 - 79; Pavlovsky and Skrynnik, 1951: 1069 - 1072), in dwellings (Moskvin, 1939: 79 - 92; Moskvin, 1939: 79 - 92; Moskvin, 1939: 59 - 78; Belous, 1939: 237 - 250), in animal quarters (Moskvin, 1939: 93 - 103; Belous, 1939: 237 - 250), in rodents burrows (Moskvin, 1939: 59 - 78); Kulyab Province: on man (Pavlovsky, 1929: 84 - 122; Masaitis, 1929: 123 - 127), other animals (Masaitis, 1929: 123 - 127), in houses and in hospital (Pavlovsky, 1929: 84 - 122); Kulyab, in houses, in rodent holes, in porcupine hole; Baba-Gabib; in village between Schirobad and Kulyab, in barns (Pavlovsky, 1936: 13 - 43); Stalinabad Province: in cave (Khodukin and Sofiev, 1931: 50 - 55); Diuschambe (Pavlovsky, 1936: 13 - 43), in cattle yard (Pavlovsky, 1929: 84 - 122); Kafirnigan (Pavlovsky, 1936: 13 - 43), in cow barn (Pavlovsky, 1929: 84 - 122); Ramit, in goat stall (Pavlovsky, 1929: 84 - 122); Nadzhi, in caves, crevices, holes, in village, on bats in cave, in barns, stalls and cattle yards (Pavlovsky, 1936: 13 - 43); Stalinabad (Pavlovsky, 1944: 1 - 79), in

caves (Pavlovsky and Skrynnik, 1945: 161 - 164; Latuishev, 1937: 82 - 90; Pavlovsky, 1936: 13 - 43; Serdyukova, 1939: 51 - 57); Gissar (Pavlovsky, 1944: 1 - 79), in porcupine holes (Pavlovsky, 1936: 13 - 43); Khanak; Regar (Pavlovsky, 1936: 13 - 43); Garm Province: Garm and nearby villages, in barns and stalls; Dukune, in farms (Pavlovsky, 1944: 1 - 79); Khait; Kalai-Khumb (Pavlovsky, 1944: 1 - 79); Gorno-Badakhshanskaya Province: Pamir-Darya and Wakhan-Darya (Pavlovsky, 1944: 1 - 79).

Turkmen S. S. R. - (Olenev, 1931: 3 - 125; Pavlovsky and Skrynnik, 1951: 1069 - 1072), in cave (Pospelova-Shtrom, 1941: 96 - 100); Stary-Merv (Pavlovsky, 1944: 1 - 79); southwestern and southern parts, in caves, burrows of porcupines (Pospelova-Shtrom, 1941: 145 - 152); central and western parts, in wall of mausoleum and in burrows of rodents; western part, in cave (Pavlovsky, 1931: 23 - 34); Ashkhabad Province: Firyuza (Pavlovsky, 1931: 23 - 34; Pavlovsky, 1944: 1 - 79); Karakala (Pavlovsky, 1944: 1 - 79; Pavlovsky and Lototzky, 1948: 125 - 146), in cave and in burrows of porcupines (Pavlovsky, 1934: 29 - 47); Ashkhabad (Pavlovsky, 1944: 1 - 79; Pavlovsky and Lototzky, 1948: 125 - 146); Mary Province: Mary; Takhta-Bazar (Pavlovsky and Lototzky, 1948: 125 - 146); Chardzhou Province: Kerki (Pavlovsky, 1929: 84 - 122; Pavlovsky, 1931: 23 - 34).

Uzbek S. S. R. - (Moskvin, 1927: 375 - 380; Olenev, 1931: 3 - 125; Pavlovsky and Skrynnik, 1951: 1069 - 1072), on man (Moskvin, 1929: 73 - 89), on sheep, cattle, dogs (Sofiev and Leonova, 1948: 265 - 268); Skobelevo St., in paint shop; Gortschokovo, in walls of swine yard; Utsch-Kurgan, inside barracks; Fedtschenko, in bazar and in house; Jokhobag, in barracks; Varganzy; Tschasch-Tepe, in house; Karasu; Khalatsch; Bisch-Bek; Gissarek; Tschun Gurak; Kzyl Imtschak; Gilian; Kul; Schut; Mussa-Bazar; Asti Duktar; Manomon; Aschikon, Sumat; Tovaschi; Schatry; Varganzy; Duaba; Mumyn-Abad (Pavlovsky, 1929: 84 - 122); eastern part; Kiarim-divana, in stable; Karabakh, in barn; Mirza-abad, in horse stable; Buzhum, in barn; Anval, on horse, in horse stable; Pap; Kuva-sai; Margelan, on man, in stalls; Zor-tasch, in horse stable; Vorukh; Gaznan, in horse stable; Sok; Gava, in barn; Tscherkaser, in barn; Okhul, on ram; Rischtan, in court yard; Tschar-Ku, in stalls (Pavlovsky, 1931: 23 - 34); Bukhara Province: (Troitzky, 1928: 275 - 276); Andizhan Province: Andizhan, in walls of cattle yard (Pavlovsky, 1929: 84 - 122); Fergana Province: Fergana (Pavlovsky, 1944: 1 - 79; Desportes and Campana, 1946: 74 - 88), in houses, in bazar (Pavlovsky, 1929: 84 - 122); Samarkand Province: Samarkand, in house; Surkhan-Darinskaya Province: Denau, on ram (Pavlovsky, 1929: 84 - 122); Kashka-Darinskaya Province: Shakhrisyabe (Pavlovsky and Lototzky, 1948: 125 - 146), in houses (Pavlovsky, 1929:

84 - 122).

Daghestan A. S. S. R. - Makhachkala (Pavlovsky, 1931: 23 - 34). Kara-Kalpakskaya A. S. S. R. - (Pavlovsky, 1944: 1 - 79; Pavlovsky and Lototzky, 1948: 125 - 146).

Caucasia - (Neumann, 1911: 125; Olenev, 1929: 305 - 314; Nuttall, et al., 1908: 79 - 80; Desportes and Campana, 1946: 74 - 88); on shores of Caspian Sea (Pavlovsky, 1931: 23 - 34).

Central Asia - (Latuishev, 1926: 21 pp.; Marzinovsky, 1927: 314 - 318; Pavlovsky, 1928: 5 - 11; Pavlovsky, 1929: 84 - 122; Olenev, 1931: 3 - 125; Olenev, 1931: 126 - 139; Pavlovsky, 1931: 73 - 84; Pavlovsky, 1932: 79 - 100; Khodukin and Sofiev, 1932: 63 - 65; Pavlovsky, 1936: 13 - 43; Popov and Akhundov, 1936: 289 - 295; Sofiev, 1941: 267 - 271; Pavlovsky and Teravsky, 1942: 120 - 121; Pavlovsky, 1943: 286 - 288; Pavlovsky and Cheskis, 1943: 55 - 56; Desportes and Campana, 1946: 74 - 88; Pavlovsky and Skrynnik, 1948: 255 - 264; Pavlovsky and Lototzky, 1948: 125 - 146), in houses, in animal quarters (Moskvin, 1929: 128 - 130; Troitzky, 1945: 75 - 79), crawling on sheep and cattle in winter (Moskvin, 1929: 128 - 130), in caves (Troitzky, 1945: 75 - 79).

Transcaspia - (Marzinovsky, 1914: 714 - 735). Transcaucasia - (Olenev, 1929: 305 - 314), on man (Yakimov, 1922: 41 - 46). Turkestan - (Pavlovsky and Shtein, 1927: 401 - 408; Pavlovsky and Shtein, 1927: 31 - 37; Latuishev, 1927: 12 pp.; Olenev, 1929: 305 - 314; Desportes and Campana, 1946: 74 - 88; Nicolle and Anderson, 1928: 746 - 748; Pavlovsky, 1930: 355 - 360).

On the following hosts **without** definite indication of locality: Ovis aries (Neumann, 1911: 125; Olenev, 1931: 3 - 125), Camelus bactrianus, Gallus domesticus (Neumann, 1911: 125), man (Olenev, 1931: 3 - 125).

Biology

Life history: Females which were kept singly with males were fertilized and they oviposited up to seven months after the males had been removed; but only the eggs laid during the first three months hatched. Oviposition took place as a rule in the autumn or at the beginning of winter; eggs laid abnormally early, for instance in July, did not hatch. The oviposition period lasted 1 - 10 days or more and the eggs were deposited singly or in batches. The number of eggs laid per female varied from 3 to 60 and averaged 26 - 27. The egg stage lasted 11 - 30 days at 15 - 18° C. and most of the eggs hatched at night (Pavlovsky and Skrynnik, 1945: 277 - 294). The number of nymph-

al stages varied from 3 to 5 even among individuals that hatched from the same batch of eggs (Pavlovsky and Skrynnik, 1939: 25 - 42). When they were fed 5 - 10 days after hatching or molting and kept at 26° C. the larval stage lasted 10 - 20 days, the first nymphal stage lasted 11 - 18 days, the second nymphal stage lasted 15 - 21 days, the third nymphal stage lasted 19 - 46 days, the fourth nymphal stage lasted 22 - 47 days and the fifth nymphal stage lasted 38 - 105 or more days. Some individuals became adults (chiefly males) after only three nymphal stages and many became adults after only four nymphal stages. At constant temperature of 26° C. the development from eggs to adult, irrespective of the number of nymphal stages, was completed in 5 - 9 months (Pavlovsky and Skrynnik, 1945: 277 - 294). For those ticks which had been allowed to feed only occasionally the development from egg to adult lasted 10 - 15 years. Since adults lived for 6 - 7 years the total cycle might be prolonged for 16 - 22 years and it probably lasted as long under natural conditions (Skrynnik, 1948: 265 - 274). It was estimated that the total life cycle could last 20 - 25 years (Pavlovsky and Skrynnik, 1951: 1069 - 1072; Pavlovsky and Skrynnik, 1945: 161 - 164).

This species attacked man and animals during the day as well as at night (Kasaitis, 1929: 123 - 127). It engorged in 20 - 30 minutes (Pavlovsky, 1929: 84 - 122) and rarely required more than 20 minutes (Pospelova-Shtrom, 1941: 96 - 100); larvae engorged on guinea pigs in 8 - 66 minutes (Pavlovsky and Skrynnik, 1945: 277 - 294).

Larvae which had been deprived of food began to die after two months; though one larva survived for three and a half months, it died a few days after being fed (Pavlovsky and Skrynnik, 1945: 277 - 294). In other studies the larvae easily survived without food for 3 - 4 months and one larva survived for 15 months (Skrynnik, 1948: 265 - 274). In still other studies the larvae survived without feeding for up to 15 months though the mortality became considerable after 6 - 7 months (Pavlovsky and Skrynnik, 1951: 1069 - 1072). The first nymphal stage survived starvation for 2 months and one nymph lived for nearly 6 months (Pavlovsky and Skrynnik, 1945: 277 - 294); one survived starvation for 18 months (Skrynnik, 1948: 265 - 274); and in another case the nymphs survived for 2 years (Pavlovsky and Skrynnik, 1951: 1069 - 1072). The second nymphal stage survived starvation for two and a half months (Pavlovsky and Skrynnik, 1945: 277 - 294) to 30 months (Skrynnik, 1948: 265 - 274) and in one case it survived for 4 years (Pavlovsky and Skrynnik, 1951: 1069 - 1072). The large nymphs survived without food for about six years (Pavlovsky and Skrynnik, 1945: 277 - 294). The third nymphal stage survived for 41 months (Skrynnik, 1948: 265 - 274) to 8 years. The fourth and

fifth nymphal stages survived for 11 years (Pavlovsky and Skrynnik, 1951: 1069 - 1072). Females allowed to feed were alive after 9 years (Pavlovsky and Skrynnik, 1945: 277 - 294) but males lived without feeding for 9 years and females for 10 years (Pavlovsky and Skrynnik, 1951: 1069 - 1072). Starving ticks remained quiescent but when disturbed they became as active as those which had fed. After being without food for 3 - 4 years they engorged somewhat more slowly than those fed once a year (Skrynnik, 1948: 265 - 274). Ticks which had not fed for 10 years were emaciated and moved with difficulty so that starvation for this period was probably close to the limit (Pavlovsky and Skrynnik, 1951: 1069 - 1072). Females which had not fed for 3 years laid viable eggs (Skrynnik, 1948: 265 - 274).

Seasonal activity: In Central Asia this tick occurred throughout the year (Pavlovsky, 1929: 84 - 122) and though it was found crawling on sheep and cattle in the winter it did not feed on them (Moskvin, 1929: 128 - 130). It also was observed during the winter in Iran in animal quarters where the temperature ranged from 8 to 22° C. (Pavlovsky, 1948: 179 - 202).

Habitats: All stages occurred in caves where the temperature was 18 - 20° C. in both winter and summer as compared with 55° C at the entrance of the cave in summer and the humidity was constant and considerable (Pospelova-Shtrom, 1941: 96 - 100; Pospelova-Shtrom, 1941: 145 - 152). They were found chiefly in the dust near burrows of rodents and the dust had a humidity of 2.88 - 6.42%. They were also found in dwellings and the percentage of infested houses increased with the dryness of the locality. Within villages they occurred in order of decreasing frequency in closed cattle sheds, hen houses, store rooms and other uninhabited quarters, roofed clay verandahs, living rooms of European type and in the outside walls of houses (Skopin, 1944: 110 - 115).

This species was scarce in the cultivated zone but was common at altitudes of 1000 - 6560 feet (Pospelova-Shtrom, 1941: 145 - 152). It was also found in the mountainous semi-desert and desert zone (Olenev, 1931: 3 - 125).

This species was reported from such man-made structures as: human habitations of all types (Moskvin, 1929: 128 - 130; Pavlovsky, 1929: 84 - 122; Pavlovsky, 1931: 23 - 34; Aluimov, 1936: 54 - 67; Pavlovsky, 1936: 13 - 43; Moskvin, 1939: 59 - 78; Belous, 1939: 237 - 250; Naumov and Mesentseva, 1942: 118 - 119; Pospelova-Shtrom, 1941: 96 - 100; Skopin, 1944: 110 - 115; Troitzky, 1945: 75 - 79; Pavlovsky, 1948: 179 - 202; Pavlovsky and Aluimov, 1939: 72 - 98), quarters of domestic animals (Moskvin, 1929: 128 - 130; Pavlovsky, 1929: 84 - 122;

Pavlovsky, 1931: 23 - 34; Pavlovsky, 1936: 13 - 43; Belous, 1939: 237 - 250; Skopin, 1944: 110 - 115; Troitzky, 1945: 75 - 79; Pavlovsky, 1948: 179 - 202; Naumov and Mesentseva, 1942: 118 - 119), caravanserais (Aluimov, 1936: 54 - 67) and in artificial caves in which grain was stored or where sheep were kept in the winter (Pavlovsky and Aluimov, 1939: 72 - 98). They have been found in such natural habitats as caves (Pavlovsky, 1931: 23 - 34; Khodukin and Sofiev, 1931: 50 - 55; Pavlovsky, 1934: 29 - 47; Pavlovsky, 1936: 13 - 43; Latuishev, 1937: 82 - 90; Pospelova-Shtrom, 1941: 96 - 100; Naumov and Mesentseva, 1942: 118 - 119; Pavlovsky, 1944: 1 - 79; Troitzky, 1945: 75 - 79; Pavlovsky, 1948: 179 - 202; Pospelova-Shtrom, 1941: 145 - 152), in burrows of various small mammals (Pavlovsky, 1936: 13 - 43; Moskvin, 1939: 59 - 78; Pospelova-Shtrom, 1941: 96 - 100; Skopin, 1944: 110 - 115; Pavlovsky and Aluimov, 1939: 72 - 98), in burrows of tortoises (Pavlovsky and Aluimov, 1939: 72 - 98), holes inhabited by birds (Pavlovsky and Aluimov, 1939: 72 - 98), under stones and in cracks in the rocks (Pospelova-Shtrom, 1941: 96 - 100).

Control Measures

Laboratory experiments were carried out to determine the minimum concentrations of chlorine, chlorpicrin and sulphur dioxide in the air which would kill nymphs and adults embedded in loess. The minimum concentrations which gave complete mortality down to a depth of 10 inches were 1.5% for chlorine and 3% for sulphur dioxide (2% under humid conditions). Chlorpicrin was effective only at concentrations which were 100 times as great as that lethal to man, and then it acted more as a repellent. Since loess adsorbed most of the chlorpicrin and because it retained it for a long time this fumigant was unsuitable in native buildings constructed of this material where no artificial ventilation was provided (Moskvin, 1939: 79 - 92). When these substances were tested under natural conditions it was found that a concentration of 3 to 4 fluid ounces per 100 cubic feet gave complete mortality in two huts but were not as effective in other huts and still less so in the sheds as the thin walls and roofs proved permeable to the fumigants. By increasing the humidity in the huts before treatment it was found that the mortality increased somewhat. Since the huts could not be re-inhabited until 6 - 10 days after fumigation it was suggested that fumigation be done only in the summer (Moskvin, 1939: 93 - 103). The percentage of mortality obtained in dwellings with chlorpicrin was variable but averaged 77% with a maximum of 100% in 3 huts in which steam was released and 71% with a maxi-

mum of 89% in three huts where steam was not used. Fumigation with chlorine and sulphur dioxide gave unsatisfactory results (Belous, 1939: 237 - 250).

It was found that paradichlorobenzene and polychlorides when used as fumigants would kill the ticks even when covered with a six inch layer of loess. The polychlorides acted faster and in smaller quantities than the paradichlorobenzene. Small crystals of paradichlorobenzene were thoroughly mixed with a two inch layer of loess covering the floor of a cave at a rate of 15 ounces per square yard and several large cyrstals were buried in the corners of the treated area. Repeated examination of loess from the fifth day after treatment revealed the presence of dead ticks of all stages (Latuishev, 1936: 174 - 178). It was later suggested that infested buildings should first be treated with carbon bisulphide, the vapors of which can be removed easily, and should then be treated with paradichlorobenzene. The slow action of this compound will prevent reinfestation and at the same time allow the building to be used (Troitzky, 1945: 75 - 79).

Ticks placed in a glass jar and sprayed with a pinene fraction of juniper oil, medium light tar oil and anabasine sulphate were killed in 5 minutes. Kerosene and a 10% solution of K soap (soap containing 50% dixanthogen) killed the ticks in 15 minutes. Desinsectalin gave complete mortality in rather more than 24 hours. SK dust gave only 80% mortality in 48 hours and pyrethrum powder gave only 36.7% mortality in the same period of time (Sosnina, 1946: 92 - 110).

Of 26 substances tested to find repellents which could be used to impregnate underclothes or bedding in camps the most effective when diluted were turpentine, an infusion of mint leaves, wood tar of specific gravity 1.057 - 1.085, ortho and meta chlorophenol, acetic acid and Malinin's fluid (a mixture of kerosene, carbolic acid, cinnamon oil and an infusion of pyrethrum flowers in turpentine) (Moskvin, 1939: 59 - 78). Some protection against tick bites at night was obtained by spraying underclothes and bedding with the mint water each evening or by wetting the bed clothes and sleeping bags with a 10% solution of pine tar and by applying undiluted tar to the earthen floor of the hut and to the legs of the bed (Moskvin, 1939: 93 - 103).

Effective protection against tick bites at night was obtained by the use of mechanical devices in conjunction with repellents. A vertical strip of treated fabric 8 inches wide was fixed around the edge of a ground sheet about 4 inches from the edge and held in an upright position by means of tapes and pegs. The upright strip of

material and the outer margins of each sheet were moistened with a repellent by means of a piece of cotton wool. After these had dried the sheets were folded and later put to use. The best repellents were a mixture of 5 grams of sodium hydroxide, 200 grams of tar and 750 cc. of water boiled together for an hour and another prepared by dissolving 50 grams of soft soap in 850 cc. of hot water, adding 100 grams of lysol or naptha-lysol, bringing the whole to a boil and applying while still warm. Sheets so treated were used for 3 and 7 consecutive nights in huts heavily infested with ticks and these measures were found to afford complete protection while other sleepers in the huts were attacked (Pisarenko and Sosnina, 1946: 101 - 108).

Ticks were confined in muslin bags and sealed in cracks of walls which were covered over with loess. These bags were removed at intervals of from 3 weeks to a little over a year. After a year 72.5% of the engorged ticks and 52.5% of the unfed ones were still living whereas 20% were dead or had disappeared. It appeared that filling up cracks in the walls might prevent ticks from crawling out but it did not give complete mortality, at least in a year (Sosnina, 1949: 380 - 382).

The ticks were also controlled by destroying rodents in houses, stopping up rodent burrows, pouring boiling water on the dust near the entrances to holes, removing dust from corners and from skirting boards of rooms and by dampening the floors of living rooms and verandahs in summer (Skopin, 1944: 110 - 115).

Relation to Disease

Relapsing Fever: O. tholozani was a natural and an experimental vector of the spirochaetes causing relapsing fever (Latuishev, 1926: 21 pp.; Starobynsky, 1922: 1445 - 1446; Moskvin, 1927: 375 - 380; Nicolle and Anderson, 1928: 746 - 748; Pavlovsky, 1929: 84 - 122; Masaitis, 1929: 123 - 127; Moskvin, 1929: 73 - 89; Pavlovsky, 1931: 23 - 34; Olenev, 1931: 3 - 125; Pavlovsky, 1931: 73 - 84; Pavlovsky, 1932: 7 - 100; Khodukin and Sofiev, 1932: 63 - 65; Pavlovsky, 1934: 29 - 47; Latuishev, 1936: 174 - 178; Pavlovsky, 1936: 13 - 43; Popov and Akhundov, 1936: 289 - 295; Zasukhin, 1937: 457 - 460; Latuishev, 1937: 82 - 90; Delpy and Rafyi, 1939: 45 - 61; Serdyukova, 1939: 51 - 57; Pavlovsky and Skrynnik, 1939: 25 - 42; Pavlovsky, 1939: 11 - 23; Sofiev, 1941: 267 - 271; Naumov and Mesentseva, 1942: 118 - 119; Pavlovsky and Teravsky, 1942: 120 - 121; Pavlovsky, 1943: 286 - 288; Pavlovsky, 1944: 1 - 79; Slavina, 1944: 85 - 87; Pavlovsky and Skrynnik, 1945: 161 -

164; Troitzky, 1945: 70 - 75; Pavlovsky and Skrynnik, 1948: 255 - 264; Pavlovsky, 1948: 179 - 202; Skrynnik, 1948: 265 - 274; Pavlovsky and Skrynnik, 1951: 1069 - 1072; Marzinovsky, 1914: 714 - 735; Yakimov, 1922: 41 - 46; Junkovsky, 1927: 56 - 66; Marzinovsky, 1927: 314 - 318; Latuishev, 1927: 12 pp.; Troitzky, 1928: 275 - 276; Pavlovsky and Aluimov, 1939: 72 - 98).

The following animals were infected with relapsing fever either by the bite of ticks, through the inoculation of emulsions of ticks or by the inoculation of blood from one animal to another: guinea pigs (Nicolle and Anderson, 1928: 746 - 748; Pavlovsky, 1932: 79 - 100; Pavlovsky and Skrynnik, 1939: 25 - 42; Naumov and Mesentseva, 1942: 118 - 119; Slavina, 1944: 85 - 87; Pavlovsky and Skrynnik, 1945: 161 - 164; Pavlovsky and Skrynnik, 1948: 255 - 264; Pavlovsky, 1948: 179 - 202; Pavlovsky and Skrynnik, 1951: 1069 - 1072; Pavlovsky and Aluimov, 1939: 72 - 98), white mice (Nicolle and Anderson, 1928: 746 - 748), rats (Nicolle and Anderson, 1928: 746 - 748; Delpy and Rafyi, 1939: 45 - 61), rodents (Pavlovsky, 1931: 23 - 34; Serdyukova, 1939: 51 - 57), hedgehog (Pavlovsky, 1931: 23 - 34), Mesocricetus auratus, Paraechinus species (Pavlovsky, 1934: 29 - 47), Meriones erythrourus (Pavlovsky and Aluimov, 1939: 72 - 98), Erinaceus europaeus (Serdyukova, 1939: 51 - 57), Nesokia indica, Cricetulus migratorius (Pavlovsky and Teravsky, 1942: 120 - 121), Dyromys nitedulus (Pavlovsky, 1943: 286 - 288; Pavlovsky and Skrynnik, 1945: 161 - 164), monkeys (Nicolle and Anderson, 1928: 746 - 748), jackal (Serdyukova, 1939: 51 - 57), dogs (Serdyukova, 1939: 51 - 57) and man (Pavlovsky, 1929: 84 - 122; Latuishev, 1937: 82 - 90; Sofiev, 1941: 267 - 271).

It was shown experimentally that the spirochaetes were transmitted only by the bite as no coxal fluid was given off during feeding. Inoculation of coxal fluid and an emulsion made from crushed infected ticks did not produce infection (Moskvin, 1927: 375 - 380). However, the spirochaetes were transmitted by inoculation of the salivary glands, the digestive tract, the malpighian tubules and the ovaries of ticks (Moskvin, 1929: 73 - 89). Transmission by biting was accomplished only after a certain interval of time had elapsed after the infective feeding. This was 1 to 2 months for the adults and it was the period of time required for development to the next stage for the larvae and nymphs. The spirochaetes were easily detected in the larvae and in the nymphs during the first 4 to 6 days after the infective meal but they became less numerous and hardly any of normal appearance were found after 20 to 30 days. The localization of the spirochaetes in the body of the tick was not discerned and no differences in behavior were noted in the infected ticks or in

the non-infected ticks. Neither starvation nor feeding on healthy animals freed the ticks from their spirochaetes or, apparently, decreased their virulence (Troitzky, 1945: 70 - 75). Spirochaetes survived in adult ticks for 1175 days and in nymphs for 1403 days. Larvae remained infective for 1230 days, nymphs for 829 days and adults for 2066 days after their parents had been infected as adults, nymphs and adults respectively (Delpy and Rafyi, 1946: 62 - 63). The infection was transmitted by the bite of a single nymph or adult. Experiments in which ticks were removed from the host before the completion of engorgement showed that feeding for one and a half to two minutes was sufficient time to affect transmission of the spirochaetes and that when feeding was interrupted a single nymph could infect three guinea pigs in succession (Pavlovsky and Skrynnik, 1939: 25 - 42).

Larvae, nymphs and adults acquired the infection in any of the active stages of their development and transmitted it in any of the subsequent stages (Pavlovsky and Skrynnik, 1939: 25 - 42; Troitzky, 1945: 70 - 75). Some workers did not observe transovarial transmission of the spirochaetes (Pavlovsky and Skrynnik, 1939: 25 - 42; Zasukhin, 1936: 457 - 460) but others reported transmission from generation to generation (Troitzky, 1945: 70 - 75; Delpy and Rafyi, 1939: 45 - 61; Pavlovsky and Skrynnik, 1948: 255 - 264). In other experiments, though the larvae from eggs laid by infected females did not transmit the infection the nymphal stage did (Zasukhin, 1936: 457 - 460). The spirochaetes were preserved from generation to generation for 14 years from the finding of the originally infected individuals (Pavlovsky and Skrynnik, 1951: 1069 - 1072).

The percentage of naturally infected ticks was 2.2 but when emulsions of stomachs were used it was found to be 3 - 4%. The percentage of spontaneously infected ticks in nature might be higher than previously believed (Slavina, 1944: 85 - 87).

A number of strains of tick-borne relapsing fever were maintained for years by keeping them in living ticks. Since the ticks were long lived and were shown to preserve virulent spirochaetes for 7 to 8 years it avoided the expense of the repeated passages through guinea pigs (Pavlovsky, 1939: 19 - 35).

Bite reaction: When ticks were allowed to feed on man hyperaemia appeared during the bite. Later the spot hardened and showed in the center a haemorrhagic dot from which oozed droplets of blood. This dot turned a dark purplish-red and enlarged to 4 - 5 millimeters across. After 12 hours it was 10 millimeters across and sharply set off; the center became paler after 24 hours and after 48 hours it developed a pinkish papule about 2 millimeters across being surrounded by an ic-

teric zone and an outer haemorrhagic zone. The first symptoms of itching appeared 6 days after the bite, when the haemorrhagic spot was already icteric. A pinkish papule persisted in the center for several weeks. No secretion of coxal fluid or of guanin from the anus was observed during the bite and the changes in the skin were ascribed to the saliva alone (Pavlovsky and Shtein, 1927: 401 - 408). An inflammatory condition was also found accompanied by a haemorrhagic papule at the site of attachment on mice (Moskvin, 1929: 208 - 213).

Miscellaneous: Anticoagulin was produced in the salivary glands of both sexes and also in the digestive tract. Emulsions prepared from the salivary glands showed in certain concentrations a haemolyzing effect on human blood. The fluid given off in the act of sucking blood showed very great anticoagulating properties and rapidly agglutinated the erythrocytes in human blood (Pavlovsky and Khodukin, 1929: 90 - 96). In addition to the salivary glands the secretion from the coxae also showed anticoagulant properties (Khodukin and Sofiev, 1931: 283 - 285).

Ornithodoros verrucosus Olenev, Zasukhin and Fenynk

Ornithodoros verrucosus Olenev, Zasukhin and Fenynk, 1934: 327 - 330; Olenev, 1934: 367 - 388; Zasukhin, 1935: 1 - 159; Pavlovsky, 1936: 9 - 22; Skrynnik, 1939: 43 - 50; Pavlovsky and Shtein, 1939: 251 - 255; Pospelova-Shtrom, 1939: 52; Pospelova-Shtrom, 1940: 618 - 622; Popov and Akhundov, 1940: 255 - 259; Pavlovsky, 1943: 286 - 288; Pospelova-Shtrom, 1947: 30 - 33; Pavlovsky and Skrynnik, 1948: 255 - 264; Skrynnik, 1948: 265 - 274; Pavlovsky and Skrynnik, 1951: 1069 - 1072.

Localities and Hosts

Azerbaijan S. S. R. - near Baku, in burrows of voles (Popov and Akhundov, 1940: 255 - 259). Georgian S. S. R. - (Pavlovsky and Shtein, 1939: 251 - 255); Tibilisi (Pavlovsky, 1936: 9 - 22). Kazakh S. S. R. Guryev Province: Mangyshlak Peninsula, in burrows of Rhombomys opimus (Zasukhin, 1935: 1 - 159). Stavropol Territory - (Pavlovsky and Shtein, 1939: 251 - 255); vicinity of Stavropol, in cave (Pavlovsky, 1936: 9 - 22) and attacked man (Olenev, Zasukhin and Fenynk, 1934: 327 - 330); Petrovskoye (Olenev, 1934: 367 - 388), in caves and attacked man

(Zasukhin, 1935: 1 - 159). Caucasia - (Pavlovsky and Skrynnik, 1948: 255 - 264).

Biology

Life history: In the laboratory oviposition was seasonal and occurred between July 1 and October 13. The eggs were not numerous and hatched in 16 - 32 days at a room temperature of 15 - 18° C. The ticks were kept at 26° C. and were allowed to engorge on guinea pigs 5 - 10 days after hatching or molting. Some passed through four nymphal stages but most passed through only three stages. The duration of the larval stage after feeding was 10 - 15 days and that of each of the nymphal stages was 13 - 17, 15 - 24, 18 - 46 and 45 - 90 days, respectively, except that some individuals remained in the third nymphal stage up to 3 months. Instances of starved ticks feeding on engorged ones were observed (Skrynnik, 1939: 43 - 50). Specimens collected in the field resisted starvation for about 3 years (Skrynnik, 1948: 265 - 274; Pavlovsky and Skrynnik, 1951: 1069 - 1072).

Habitats: All stages were found in caves (Olenev, Zasukhin and Fenynk, 1934: 327 - 330; Zasukhin, 1935: 1 - 159; Pavlovsky, 1936: 9 - 22), in burrows of Rhombomys opimus (Zasukhin, 1935: 1 - 159) in burrows of voles (Popov and Akhumdov, 1940: 255 - 259) and in the semi-desert zone (Zasukhin, 1935: 1 - 159).

Control Measures

Laboratory experiments were done on the effect of DDT of Soviet manufacture called pentachlorin. In a test at 20 - 23° C. a nymph and a female were left for 2 hours in a wide test tube containing several small portions of DDT and subsequently kept at 18° C. The nymph showed symptoms of paralysis on the third day and died in 10 days and the female showed symptoms of paralysis on the fourth day and died in 12 days. Three drops of a saturated solution of DDT in liquid paraffin were applied by brush at 40 - 45° C. to the dorsal or ventral surface but not on the spiracle. A hungry nymph so treated on the ventral surface died in 5 days and a hungry nymph treated on the dorsal surface died in 2 weeks while an engorged nymph survived 3 weeks. DDT was applied over one-half of the closely clipped surface of the abdomen of a guinea pig and an unfed male and female were placed on this area. As a control another female from the same lot was placed on the untreated half of the abdomen. All three ticks en-

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gorged rapidly and dropped from the host. The male became paralyzed in 3 days and died in 10 days; the female was paralyzed in 7 days and died in 30 days; and the control female was paralyzed in 4 days and died in 24 days. It was thought that the control female became affected by having been touched with contaminated forceps (Pospelova-Shtrom, 1947: 30 - 33).

Relation to Disease

Relapsing Fever: O. verrucosus transmitted tick-borne relapsing fever (Pavlovsky, 1936: 9 - 22; Skrynnik, 1939: 43 - 50; Pavlovsky and Shtein, 1939: 251 - 255; Popov and Akhundov, 1940: 255 - 259; Pavlovsky, 1943: 286 - 288) and was found naturally infected with spirochaetes (Pavlovsky, 1936: 9 - 22; Skrynnik, 1939: 43 - 50; Popov and Akhundov, 1940: 255 - 259; Pavlovsky and Skrynnik, 1948: 255 - 264). This tick was not found in places where it would normally come in contact with man and this explained the rare occurrence of tick-borne relapsing fever in the Caucasus (Pavlovsky, 1936: 9 - 22). The infection was transmitted to guinea pigs and the spirochaetes were present in the blood for 14 - 29 days but all recovered as did others infected by sub-inoculation (Pavlovsky, 1936: 9 - 22; Popov and Akhundov, 1940: 255 - 259). The infection was also transmitted to white mice, rats, Lagurus lagurus, Allactaga elater, man (Pavlovsky, 1936: 9 - 22), Dryomys nitedulus (Pavlovsky, 1943: 286 - 288) and to other animals (Popov and Akhundov, 1940: 255 - 259). In investigations on reservoirs 2 of 17 jerboas (Allactaga) were found infected in nature and a strain was isolated from the brain of 10 Chilotus (Microtus) socialis which was fatal to guinea pigs and pathogenic to man (Popov and Akhundov, 1940: 255 - 259). Ticks kept in the laboratory were still living after 4 years and some that were naturally infected with spirochaetes continued to infect guinea pigs throughout that period (Skrynnik, 1939: 43 - 50). Larvae, nymphs and adults which were the offspring of a batch known to include infected adults failed to transmit the spirochaetes to guinea pigs (Skrynnik, 1939: 43 - 50; Pavlovsky and Skrynnik, 1948: 255 - 264). Though the bite was reported to cause acute pain (Olenev, et al., 1934: 327 - 330) it was not found to be painful by other observers (Skrynnik, 1939: 43 - 50).

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