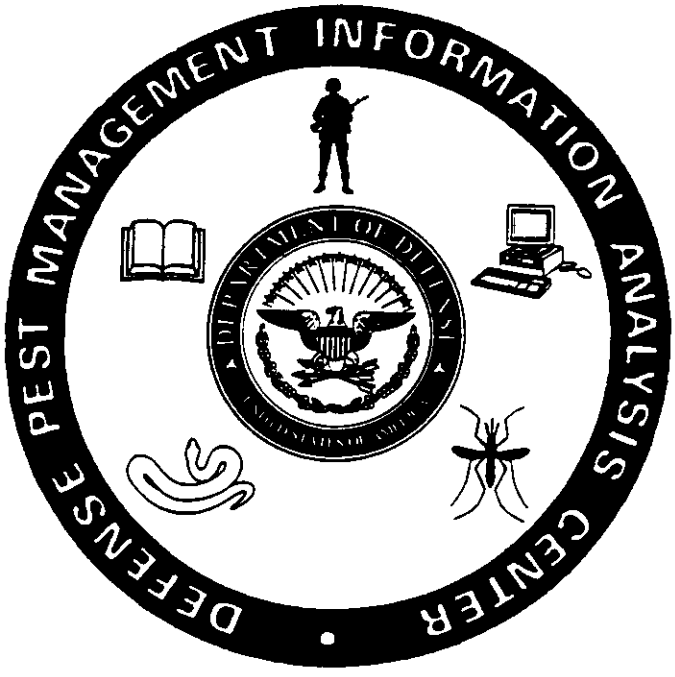
DISEASE VECTOR ECOLOGY PROFILE



THE KOREAS

April 1994

Armed Forces Pest Management Board
DEFENSE PEST MANAGEMENT INFORMATION ANALYSIS CENTER
Forest Glen Section, WRAMC
Washington, D.C.
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PREFACE

Disease Vector Ecology Profiles (DVEPs) are concise summaries of vector-borne and other militarily significant diseases that occur in specific countries. DVEPs focus on vector-borne diseases and emphasize essential epidemiology, vector bionomics, behavior, and pesticide resistance. Selected bibliographies of pertinent disease and disease vector literature are included.

DVEPs are compiled from unclassified literature and are intended to provide a historical profile of arthropod-borne disease epidemiology in the recent past for selected geographical areas. **These publications are for official use only**.

The epidemiology of arthropod-borne disease is constantly changing, especially in Third World countries undergoing rapid development and ecological change and those areas experiencing migrations of large refugee populations as a result of civil strife. Therefore, DVEPs should be supplemented with recent information on foreign public health status and medical developments.

Current Information: Current disease risk assessments, additional information on other parasitic and infectious diseases, and other aspects of medical intelligence can be obtained from the Armed Forces Medical Intelligence Center (AFMIC), Fort Detrick, Frederick, MD 21701, (301) 619-7574, DSN 343-7511. Additional information can be obtained from the Navy Preventive Medicine Information System (NAPMIS), which maintains up-to-date Disease Risk Assessment Profiles (DISRAPs) and Disease Vector Risk Assessment Profiles (VECTRAPs) on most countries of the world. DISRAPs and VECTRAPs can be obtained by contacting the Navy Environmental Health Center (NEHC), Norfolk, VA 23513, (804) 444-7575 extension 456, DSN 564-7575 ext 456.

DoD Component Medical Department Activities that can provide updated information for Korea and other countries in the Pacific area:

USA:	Commander LA Detachment 5th Preventive Medicine Unit APO AP 96205-0020	DSN: 725-4925
	Medical Entomologist USAPAC EHEA - Sagami, Japan Unit 45008 APO AP 96343-0079	DSN: 268-4835/5113
USAF:	Medical Entomologist (Okinawa) Det 3 Armstrong Lab/ECB Unit 5213 APO AP 96368-5213	011-8161173-41769 DSN: (315) 634-1769 FAX: 1429
USN:	Medical Entomologist (Pearl Harbor) NEPMU 6 BOX 112 Pearl Harbor, HI 96860-5040	(808) 471-9505 FAX: 474-9361
	Medical Entomologist (Okinawa) Naval Hospital, Okinawa PSC 482, Box 244, Occup & Prev Med Serv FPO AP 96362-1695	DSN: 643-7235/7426

Specimen identification support assistance and identification keys can be provided by the organizations

listed above and by the Walter Reed Biosystematics Unit, Museum Support Center, Silver Hill, MD (301) 238-3165.

Emergency Procurement of Insect Repellents, Pesticides and Equipment: Deploying forces often need pesticides and equipment on short notice. The Defense Logistics Agency has established Emergency Supply Operations Centers (ESOCs) to help such forces meet their needs.

> **For insect repellents, pesticides and respirators**: contact the Defense General Supply Center ESOC at: DSN 695-4865 or commercial (805) 275-4865. This ESOC is staffed 7 days a week and 24 hours a day.
>
> **For application equipment**: contact the Defense Construction Supply Center ESOC at: DSN 850-2271/3191 or commercial (614) 238-2271/3191.
>
> **For personal protection equipment (bed nets, head nets, etc.)**: contact the Defense Personnel Support Center at DSN: 444-3042/3043 or commercial (215) 737-3042/3043.

Contingency Operations Assistance: the AFPMB is staffed with a Contingency Liaision Officer (CLO) who can help identify the appropriate DoD personnel, equipment, and supplies necessary for vector surveillance and control during contingencies. Contact the CLO at DSN 291-5191 or commercial (301) 427-5191, and by FAX at DSN 291-5045 or commercial (301) 427-5045.

DPMIAC Services: In addition to DVEPs, DPMIAC can provide bibliographic literature searches of its extensive database on pest management, medical entomology, pest identification and pesticide toxicology. DPMIAC can also conduct on-line computer searches of other worldwide biomedical databases. DPMIAC publishes the Technical Information Bulletin (TIB), Technical Information Memoranda (TIMs), and the Military Pest Management Handbook. Telephone (301) 427-5365, DSN 291-5365.

DPMIAC operates an electronic bulletin board system (BBS) that can be accessed through computer modem. The BBS has products of current operational interest and recent editions of the Technical Information Bulletin (TIB) available for downloading to customer computer stations. The BBS phone number is (301) 427-5121.

Acknowledgements: This DVEP was updated and expanded to cover the entire Korean peninsula at the request of US Pacific Command. It was revised by Dr. Richard Robbins and Capt Armando Rosales, USAF, with editorial review by CDR Tim Dickens, USN, and LtCol Robert McKenna, USAF. Color maps were provided by the Central Intelligence Agency Map Services Center. Mrs. Ola Tilghman provided word processing and Charlene Young production and distribution.

DVEPs are designed to complement documents obtained from AFMIC and NEHC. Every effort is made to ensure their accuracy. Please provide your additions, corrections, or suggestions to Chief, DPMIAC.

The Koreas

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INTRODUCTION

NORTH KOREA (Democratic People's Republic of Korea)

North Korea occupies the rugged and mountainous Korean peninsula north of the Demilitarized Zone (DMZ) that runs along the 38th parallel. The Republic of Korea (South Korea) is directly south, China lies to the north, the Yellow sea to the west, and the Sea of Japan is on the east. North Korea is divided into 9 provinces and 3 special cities: Chagang and Yanggang Provinces in the north-central part of the country bordering China; North Hamgyong, South Hamgyong and Kangwon Provinces along the Sea of Japan; North P'yongan, South P'yongan and South Hwanghae Provinces along the Yellow Sea; North Hwanghae Province in the south-central part of the country; and Kaesong, Namp'o and P'yongyang Cities.

The Korean peninsula is rugged and mountainous, especially along the east coast and in the central interior. North Korea covers 47,000 square miles (slightly smaller than Mississippi) or about 55% of the peninsula. Nearly 65% of North Korea's total area consists of mountains no more than 3,280 ft high; 15% of the country includes peaks that rise above 3,280 ft. The remaining area is lowland or plains.

Winters are long, cold and dry, especially in the northern interior provinces of Chagang and Yanggang, where temperatures may fall below freezing as long as five months (avg. January temperature -6^{N}F). The east coast is generally warmer during winter months, with an average January temperature of 15^{N}F at Kimch'aek and 25^{N}F at W4nsan. Average January temperatures on the west coast range from 15.5^{N}F at Sinßiju on the Yalu River to 22.6^{N}F at Haeju. Summers are short, hot and humid with much more uniform temperatures across the country (avg. 70^{N}F). The growing season is only two months long in the north, four in the south. Roughly 60% of the rain falls between June and September. Average annual rainfall is 22-26 inches.

The 22.6 million North Koreans (1993 est.) chiefly occupy the coastal lowlands, particularly in the west and south. P'y4ngyang is the largest city at 1.3 million. North Koreans are ethnically homogeneous, speak Korean (with many Chinese loan words) like their neighbors to the south, and are universally literate. Traditionally, the country's backbone was agriculture but, in recent years, there has been great industrialization.

SOUTH KOREA (Republic of Korea)

South Korea (ROK) covers an area of 38,211 square miles (slightly larger than Indiana) or about 45% of the Korean peninsula. China lies across the sea to the southwest and Japan is 115 miles off the southeast coast. South Korea is divided into 9 provinces and 6 special cities: Kangwon Province in the northeast, Kyonggi Province in the northwest, North and South Kyongsang Provinces along the Sea of Japan, North and South Ch'ungch'ong

Provinces centrally and west along the Yellow Sea, North and South Cholla Provinces in the southwest along the Yellow Sea, Cheju Province, a large island across the Korea Strait; and Inch'on, Kwangju, Pusan, Seoul, Taegu and Taejon Cities.

The five major physiographic regions of South Korea are the extensive Central Region, the Eastern Littoral, the Southern Mountain and Valley Region, the Southern Littoral, and the Naktong River Basin. The Central Region slopes southwestward from the T'aebaek Range, encompassing hills and alluvial plains before ending in the much indented west coast. Along the shallow Yellow Sea, extensive mudflats are exposed to a tidal range of as much as 30 ft. Despite navigational difficulties, many small ports occur in this area.

The Eastern Littoral is a narrow strip of foothills less than 25 miles wide between the T'aebaek Range and the Sea of Japan. The Sobaek Range, branching from the T'aebaek, dominates the Southern Mountain and Valley Region. The Southern Littoral Region includes ridges of the Sobaek Mountains that run into the sea, producing a highly irregular southern coastline. An extensive delta has been formed by the Naktong River, which drains a complex of basins and floodplains separated by low hills. The Naktong River empties into the Sea of Japan a few miles west of Pusan, the second largest city and a major port. The volcanic island of Cheju-do lies 55 miles off the southern tip of the ROK and is distinct from the mainland in ecology and climate.

Climate in the ROK is temperate with four seasons similar to those of the eastern US. Summers are hot, humid and rainy while winters are cold, dry and windy. Little snowfall accumulates except in the T'aebaek Mountains. Precipitation is usually over 40 in. per year with two-thirds occurring during the rainy months of June to September. Typhoons with torrential rains occur usually in August, but may throughout the year.

Like the North Koreans, South Koreans are socially and linguistically homogeneous. In 1993 the population was 44.6 million with a growth rate of 1.05%. This gives the ROK one of the world's highest population densities, with over 11 million people in the Seoul/Inchon area and 3 million people in the port of Pusan. Over 10% of the people in the ROK originally came from North Korea during and after the Korean conflict.

The national language is Korean but most Koreans are also fluent in English, which is taught in all secondary schools. Because Korea was formerly occupied by Japan, many older Koreans also know Japanese. The literacy rate is over 96% due to an excellent public education system that extends from primary schools to the university level. There is one doctor for every 1,500 people. Life expectancy (as of 1993) is 70 years (females 73.7 years; males 67 years). Korea's traditional religions are Buddhism and Shamanism, although Confucianism remains a dominant cultural influence. About 48.6% of the population is Christian - one of the highest levels of Christianity in Asia.

DISEASE SUMMARY

(Prioritized in estimated order of military importance)

Note: Detailed medical information on North Korea is limited.

Militarily Important Vector-Borne Diseases

JAPANESE ENCEPHALITIS: Virus primarily transmitted by the bite of infected *Culex tritaeniorhynchus* mosquitoes. The most significant vector-borne disease in the Koreas, occurring in both urban and rural areas. Seasonal - July to October, peaking in August. Vector mosquito biting activity peaks at sunset but continues all night. The highest endemic areas are in the southern provinces, bordering the coast. The first documented epidemic in Korea occurred in 1949 with 5,616 cases and 2,727 deaths; the worst epidemic recorded was in 1958 with 6,897 cases and 2,177 deaths. Only sporadic outbreaks have been seen recently, probably a result of massive immunization and mosquito abatement programs. US personnel are at risk - use of the DoD repellent system (DEET lotion for skin, permethrin for uniforms, tents and bed nets) should provide protection (See Appendix F, Personal Protective Measures).

HEMORRHAGIC FEVER WITH RENAL SYNDROME (HFRS): Hantavirus transmitted through aerosols from bodily fluids, especially urine or excreta of infected rodents. HFRS was a major disease in UN troops during the Korean War. Historically, most cases have been reported in rural populations and soldiers along the DMZ, but sporadic cases have occurred among civilians and soldiers throughout the ROK. Cases in urban areas have incriminated rats as reservoir hosts. After an incubation period of 12-23 days, HFRS manifests itself in headaches, muscle aches, fever, hemorrhage and proteinuria. Severe hemorrhagic and kidney involvement may lead to renal failure, shock and death. Seasonal incidence is variable, with the majority of cases occurring from October to December and a small peak in May and June.

MALARIA: Primary malaria vector is *Anopheles sinensis*. Number of malaria cases has increased rapidly since 1993. In 1998, 6,249 cases of vivax malaria were reported in South Korea. Vector mosquitoes begin biting at dusk and continue throughout the night.

DIARRHEAL DISEASES: Primarily fecal-oral, but filth flies may act as mechanical vectors. Diarrheal diseases are endemic at low to moderate levels. Pathogens include bacteria (*Aeromonas* spp., *Campylobacter* spp., *Escherichia coli*, *Salmonella* spp., *Shigella* spp., *Vibrio parahaemolyticus*, *Yersinia enterocolitica*) and Protozoa (*Cryptosporidium* spp., *Entamoeba histolytica*, *Giardia lamblia*). Rotavirus and enteric adenoviruses have been reported as causes of gastroenteritis among indigenous children and newly deployed US forces. Sanitation and hygiene to include fly control, exclusion, and source reduction should be strongly emphasized.

EPIDEMIC TYPHUS: Disease is transmitted by crushing an infected body louse or its feces

into bite wounds or abrasions during scratching. Historically, a major disease in Korea, with one of the worst epidemics occurring during the Korean conflict (1951), when over 32,000 cases and 6,000 deaths were reported. Cases have declined to almost none over the last 40 years. Man is considered the only reservoir. Body lice usually stay in clothing, where the eggs are commonly deposited in seams. Temperatures 4-5 degrees F above human body temperature are fatal to adult lice within a few hours. Infestations are usually acquired through direct contact with louse-infested persons or infested clothing/bedding. Outbreaks are typically associated with military conflict, natural disasters, or the relocation of populations.

SCRUB TYPHUS: Transmitted by the bite of chigger mites. Outbreaks are scattered and sporadic, usually limited to rural areas, overgrown fields or transitional vegetation. Cases are reported throughout the year but peak in autumn. A primary skin ulcer (eschar) often appears at the site of chigger attachment. Febrile onset occurs several days after infection. Late in the first week of fever, a dull red maculopapular eruption appears on the trunk and extends to the extremities. Cough and evidence of pneumonitis are common. In untreated cases, the fatality rate is highly variable and appears dependent on where infection was acquired. Two cases of scrub typhus were reported in US personnel operating in South Korea in 1992.

Other Vector-Borne Diseases of Potential Military Importance

RELAPSING FEVER: Transmission occurs when an infected louse or louse feces are crushed into bite wounds or abrasions when scratching. The body louse is the primary vector, but the head louse presumably is a potential vector. Rare in the ROK, but an epidemic occurred in 1951 in association with a louse-borne typhus epidemic. Over 2,700 cases were reported with 246 deaths. Duration of illness is 13-16 days. Mortality is 1-10% when untreated.

MURINE TYPHUS: Transmitted by scratching fleas or flea feces into an abrasion. Uncommon in the ROK, but sporadic outbreaks have occurred, especially around seaports and warehouses. Infection may occur through inhaling flea feces that may remain infective for years. Incidence figures are not available since cases have been included under epidemic typhus.

TICK-BORNE VIRAL ENCEPHALITIDES: Vectors, primarily *Ixodes persulcatus*, are reported from the ROK, but tick-borne encephalitides are of minor importance. Ticks or a combination of ticks and mammals appear to act as reservoirs. Larvae and nymphs of *Ixodes persulcatus* are associated with a wide variety of small mammals and birds; adults parasitize larger wild and domestic animals and man.

FILARIASIS: Microfilarial nematodes transmitted through the bite of infected mosquitoes, primarily *Aedes togoi* and *Anopheles sinensis.* Periodic type Malayan filariasis is the only endemic form. Low-level rural foci exist along the southern coast and on Cheju-do. Isolated

foci have been reported from the cities of Yongju, Kwangju and Pusan. Vector mosquitoes breed in rock pools, brackish tidal water, and artificial containers (jars and cisterns) of rain water between May and October, with population peaks in spring and fall.

MILITARILY IMPORTANT VECTOR-BORNE DISEASES

JAPANESE ENCEPHALITIS (JE)

INFECTIOUS AGENT*:* Virus (Togaviridae: *Flavivirus*).

EPIDEMIOLOGY: Most important vector-borne disease in the country, occurring in both urban and rural areas. Seasonal from late July through October, peaking in August and September. The highest endemic areas are in the southern provinces bordering the coast. This disease has been recognized since the 1930s but was first isolated in 1946 from a US soldier. The first epidemic occurred in 1949 with 5,616 cases and 2,727 deaths. The worst epidemic to date was in 1958 with 6,897 cases and 2,177 deaths. Outbreaks occur annually with fluctuations in the number of cases. The most recent epidemic was in 1982 with almost 3,000 suspected cases (1,197 confirmed) and 280 suspected deaths (40 confirmed); no US military cases were reported. Children under 14 account for over 90% of cases, with the highest mortality in those aged 5-9. For every reported case, it is likely that 500-1,000 subclinical cases occur. Only sporadic outbreaks have been seen since the 1982 epidemic, probably a result of massive immunization and mosquito abatement programs. For US personnel at risk, use of the DoD repellent system (DEET lotion for skin, permethrin for uniforms, tents and bed nets) should provide protection.

VECTOR TRANSMISSION: Bite of infected mosquitoes.

PRIMARY VECTOR:	*Culex tritaeniorhynchus*
POTENTIAL VECTORS:	*Aedes togoi*
	Aedes vexans nipponii
	Culex bitaeniorhynchus
	Culex pipiens pallens

VECTOR BIONOMICS: *Culex tritaeniorhynchus*

Breeds in rice fields, marshes, ground pools and stagnant water from May through September, peaking in August. This species adapts well to artificial containers. Prefers pigs and cows, and apparently feeds on man only during high population densities or in the absence of preferred hosts. Biting activity peaks the first hour after sunset but continues throughout the night. Adult females begin to overwinter in October, presumably within banks and stone walls of terraced rice paddies or dense decaying vegetation. Domestic pigs and birds act as amplifying reservoir hosts, maintaining infective levels of JE virus during epidemic periods only. Antibodies to JE have been found in 90-100% of all swine slaughtered in August and September.

HEMORRHAGIC FEVER WITH RENAL SYNDROME (HFRS) (Epidemic Hemorrhagic Fever, Korean Hemorrhagic Fever, Nephropathia Epidemica, Hemorrhagic Nephrosonephritis)

INFECTIOUS AGENT: Hantaviruses (Bunyaviridae).

EPIDEMIOLOGY: Korean Hemorrhagic Fever was a major disease among UN troops between 1951 and 1954. Similar illness occurs throughout most of the Eurasian land mass. Historically, most cases have been reported from rural populations, especially farmers and soldiers around the DMZ. But since 1970 sporadic cases have occurred equally among civilians and soldiers throughout the ROK - up to 1,000 indigenous cases are estimated annually. Cases occur every year in US forces deployed to South Korea: 14 cases (2 fatal) in 1989. Two cases were recently diagnosed in Marines training near Pohang, along the southeast coast. The field mouse *Apodemus agrarius* is the main reservoir. Cases of a milder, urban form of Korean HFRS (Seoul virus) have incriminated rats (*Rattus rattus* and *R. norvegicus)* as reservoirs. Infection of laboratory personnel working with infected rodents has occurred. After an incubation period of 12-23 days, HFRS manifests itself by headache, muscle ache, fever, hemorrhage and proteinuria. Severe hemorrhagic and kidney involvement may lead to renal failure, shock and death. Subclinical, antibody-producing cases of HFRS may occur in 40% of the Korean population. Seasonal variations in incidence have been noted, with the majority of cases in October-December and a small peak in May-June; these coincide with fluctuations in the rodent population. Korea University in Seoul has been designated a WHO Collaborating Center for HFRS research.

TRANSMISSION: Aerosols from bodily fluids--especially urine--or excreta of infected rodents. No person-to-person transmission has been documented. Horizontal transmission via grooming and mating in the reservoir population maintains the virus. Attempts to isolate the Hantaan antigenic subtype from over nine species of rodent ectoparasites, including mites, lice and fleas, have largely failed, but experimental evidence indicates that various hemogamasid mites may pass the virus between reservoir rodents by biting and may maintain the virus transovarially and transstadially. See Appendix I, USAEHA Recommended Hantavirus Control Measures.

SUSPECTED VECTORS: Hemogamasid laelapid mites

BIONOMICS: Out of eight species of field rodents captured in an endemic area, only the Old World wood or field mouse, *Apodemus agrarius corea,* was found positive for HFRS, with a 25% infection rate. Experimental infection of nine wild rodent species produced viremia only in *Apodemus agrarius corea* and *A. a. jejuensis*. Currently, Cheju-do is free of HFRS and all *Apodemus* tested have been negative.

Experimental infection of 12 species of colonized rodents yielded antibody production in

five and Hantaan virus production in two. Experimentally infected Norway rats, *Rattus norvegicus*, produced antibodies and are considered probable reservoirs of a milder form of the disease (Seoul virus) in urban areas.

Another mild form of HFRS, Puumala virus, is associated with red-backed mice, *Clethrionomys* spp., and was first reported from the ROK in 1991. Infected rodents experience a short viremia of one week, 5-10 days post-inoculation. No acute illness develops and antibodies are produced after three weeks. Virus is found in the lungs, kidneys, salivary glands and liver. Virus excretion in urine, saliva and feces occurs from day 10 through day 360 post-inoculation.

DIARRHEAL DISEASES

INFECTIOUS AGENTS: Pathogens include bacteria (*Aeromonas* spp., *Campylobacter* spp., *Escherichia coli*, *Salmonella* spp., *Shigella* spp., *Vibrio parahaemolyticus*, *Yersinia enterocolitica*) and Protozoa (*Cryptosporidium* spp., *Entamoeba histolytica*, *Giardia lamblia*). Rotavirus and enteric adenoviruses have been reported as causes of gastroenteritis among indigenous children and newly deployed US forces.

EPIDEMIOLOGY: Limited sampling in South Korea during 1989 found infection rates of 0.5 percent and 1.6 percent, respectively, for amebiasis and giardiasis.

TRANSMISSION: Enteric diseases are acquired from contaminated food and water. Filth flies may serve as mechanical vectors. Sanitation and hygiene to include fly control, exclusion, and source reduction should be strongly emphasized.

PRIMARY VECTORS: House fly, *Musca domestica*, and other synanthropic flies

VECTOR BIONOMICS: Larvae develop in excrement, garbage and latrines, feeding on waste materials and associated microorganisms. Though capable of flying considerable distances, most synanthropic species disperse no more than a few km from their breeding sites, with the result that illness from fly-borne enteric pathogens is frequently focal. Filth flies are extremely prolific, and populations decimated by control measures or weather variables can quickly recover their former numbers.

EPIDEMIC TYPHUS

INFECTIOUS AGENT: *Rickettsia prowazeki.*

EPIDEMIOLOGY: An important disease of worldwide distribution. Historically over 1,000 cases per year were reported from Korea, with a 10-15% fatality rate. One of the worst

epidemics occurred in 1951 during the Korean conflict with over 32,000 cases and 6,000 deaths. During the last 30 years, the disease has almost disappeared from the country. Cases declined throughout the 1960s and no cases have been reported since 1968.

VECTOR TRANSMISSION: Man is considered the only reservoir of infection, though closely related rickettsiae have been isolated from other animals. *Rickettsia prowazeki* multiplies in the louse gut, which ruptures releasing the organism to the lumen where it is voided with feces. Human infection occurs from louse feces or body contents being rubbed into abrasions when the louse is crushed during scratching. The pathogen may also enter through mucous membranes or inhalation of louse feces. *Rickettsia prowazeki* remains virulent in dry feces for over 60 days. Patients with a mild, chronic form of recrudescent typhus (Brill-Zinsser disease) can serve as reservoirs of infection.

PRIMARY VECTOR: *Pediculus humanus humanus* (body louse)

VECTOR BIONOMICS: Lice usually stay in clothing, where eggs are commonly deposited in seams. The incubation period is 5-7 days near the body. Hatching is reduced or prevented by exposure to temperatures above 38 degrees C (100 deqrees F) or below 23 degrees C (75 degrees F). Eggs are the most resistant stage. Maturity is reached 2-3 weeks after oviposition. Lice live approximately 30-40 days but die in 10 days or less without food. Most infected lice die in 8-12 days; survivors remain infective for life. Temperatures ca. 4-5 degrees F above that normally found on the host are fatal to adult lice in a few hours (lice leave typhus patients with high fevers). Temperatures at or below 20 C are fatal to adults if prolonged. Infestations are usually acquired via direct contact with louse-infested persons or infested clothing or bedding. Outbreaks have been associated with the relocation of populations during military conflicts or natural disasters.

SCRUB TYPHUS (Chigger-borne Rickettsiosis, Tsutsugamushi Disease)

INFECTIOUS AGENT: *Rickettsia tsutsugamushi* (= *R. orientalis*).

EPIDEMIOLOGY: Endemic throughout the Korean peninsula. Outbreaks are scattered and sporadic, usually limited to rural areas, overgrown fields or transitional vegetation. Seasonal incidence peaks occur in autumn but cases have been reported in every month of the year. In Korea, first reported in 1951 when 6 cases occurred among UN personnel. Scrub typhus has been documented in US personnel as late as 1992 when two cases were reported in USAF security police stationed at Osan AB.

VECTOR TRANSMISSION: Transmitted to man by the bite of infected larval trombiculid mites (chiggers) in the subgenus *Leptotrombidium*. Chiggers are also the primary reservoir of infection, which is maintained by transovarial passage.

PRIMARY VECTORS: *Leptotrombidium* (*Leptotrombidium*) spp.

VECTOR BIONOMICS: Eggs are laid singly and loosely in low, humid grassy areas. About 1-5 eggs are laid daily for 6-12 weeks. The females then pause for 2-6 months depending on climate before resuming oviposition. The egg stage lasts 5-7 days, the larva developing inside the cracked ovum (deutovum) for another 5-7 days. The 6-legged larva then emerges and remains in the immediate area until it encounters a host (usually any murid rodent). Chiggers feed on serum exudate, rarely imbibing blood, for 2-3 days. Engorged larvae disengage, drop off and enter a pupa-like stage (nymphochrysalis) for 7-10 days. An 8-legged velvety nymph emerges, and within two weeks another pupa-like stage (imagochrysalis) occurs lasting 12-15 days. Adults emerge and may live up to 15 months. Nymphs and adults are free-living and appear to feed on insect eggs and small, soft, inactive soil invertebrates. Mite populations often form highly localized aggregations ("mite islands"), resulting in hit-or-miss human exposure.

MALARIA

INFECTIOUS AGENT: *Plasmodium vivax.*

EPIDEMIOLOGY: With over 700 cases in 1973, malaria rapidly declined following a WHO eradication program. *Plasmodium vivax* malaria then reemerged in the Republic of Korea in 1993. The number of cases has tripled each year since, with more than 1,600 cases reported in 1997 and 6,249 cases in 1998. The disease is localized along the western Demilitarized Zone. It has been suggested by many authors that the initial source of the re-emerging malaria was infected mosquitoes which had flown from the northern part of the DMZ.

VECTOR TRANSMISSION: Bite of infected *Anopheles* mosquitoes.

PRIMARY VECTOR: *Anopheles sinensis*
POTENTIAL VECTOR: *Anopheles yatsushiroensis*

VECTOR BIONOMICS: *An. sinensis*

In both Koreas, breeds mainly in rice fields and irrigation systems from early May to October, peaking in July and August. Adults rest in outdoor sheds and stables but are also found in gardens and vegetation. This species definitely prefers bovine blood but will bite man readily outdoors or inside lighted houses. Biting begins at dusk and continues throughout the night. Females begin to hibernate in late October in outdoor storage sheds, becoming active again in April.

OTHER VECTOR-BORNE DISEASES OF POTENTIAL MILITARY IMPORTANCE

RELAPSING FEVER

INFECTIOUS AGENT: The spirochete bacterium *Borrelia recurrentis.*

EPIDEMIOLOGY: Rare in the ROK. An epidemic occurred in 1951 in association with louse-borne typhus. Over 2,700 cases were reported with 246 deaths. No cases have been reported since 1962. Outbreaks are associated with squalor, famine and overcrowding.

VECTOR TRANSMISSION: Transmission from man to man is by infected lice. Spirochetes are taken up by lice feeding on infected hosts. They enter the louse hemocoel and multiply. Lice are highly infective after 6 days and remain so for life (30-40 days). Spirochetes enter man through skin abrasions caused when scratching a crushed louse. They do not occur in louse saliva or feces and infection does not result from vector bites alone. The pathogen may also enter through contaminated mucous membranes.

PRIMARY VECTOR: *Pediculus humanus humanus* (see EPIDEMIC TYPHUS)
POTENTIAL VECTOR: *Pediculus humanus capitis* (head louse)

VECTOR BIONOMICS: The two louse subspecies are similar, but the head louse is largely confined to the scalp.

MURINE TYPHUS

INFECTIOUS AGENT: *Rickettsia typhi* (= *R. mooseri*).

EPIDEMIOLOGY: Uncommon in the ROK. Historically, sporadic outbreaks have occurred, especially around seaports and in warehouse areas. No incidence figures are available since cases have been included under epidemic typhus. Three cases of murine typhus were confirmed in 1961, but no outbreaks have been reported.

VECTOR TRANSMISSION: Infection from contamination of abraded skin or mucous membranes with feces or crushed bodies of infected fleas. Not transmitted by bite. Infection may be acquired through inhalation of flea feces, which remain infective for years. Fleas themselves remain infective for over 50 days, probably for life. The flea life cycle is apparently unaffected by rickettsiae.

PRIMARY VECTOR: *Xenopsylla cheopis* (Oriental rat flea)

VECTOR BIONOMICS: Female fleas produce 300-400 eggs over a lifetime. These are laid

in scattered clusters in or near the nests of the reservoir hosts, chiefly the synanthropic rats *Rattus rattus* and *R. norvegicus*. Eggs hatch 2-14 days later and the larvae feed on organic materials, chiefly blood rich fecal material dropped by the female flea in the nest area. There are three larval instars. Pupation takes place in a loose, silken cocoon to which pieces of debris adhere. Adults may remain in their cocoons if meteorologic conditions are unfavorable (e.g. low temperatures, low humidity). The life cycle may be completed in as little as two or three weeks if conditions are optimal. Adult fleas can live for several months under high humidity and moderate temperatures. *Xenopsylla cheopis* is the most numerous and widely distributed rat flea in the ROK.

TICK-BORNE VIRAL ENCEPHALITIDES

INFECTIOUS AGENTS: A complex within the flaviviruses (Togaviridae).

EPIDEMIOLOGY: Reported from the ROK but of minor importance. Ticks or a combination of ticks and mammals appear to act as reservoirs.

VECTOR TRANSMISSION: Transmitted by the bite of infected ixodid ticks.

PRIMARY VECTOR:	*Ixodes persulcatus*
SECONDARY VECTORS:	*Dermacentor* spp.
	Haemaphysalis spp.
	Ixodes spp.

VECTOR BIONOMICS: Several tick species have been recorded as vectors. Larvae and nymphs of *Ixodes persulcatus* are associated with a wide variety of small forest mammals and birds; adults parasitize larger wild and domestic animals and man.

FILARIASIS

INFECTIOUS AGENT: The microfilarial nematode *Brugia malayi*.

EPIDEMIOLOGY: Periodic type Malayan filariasis is the only endemic form. Microfilariae circulate in the bloodstream with a nocturnal periodicity. Adult filarial worms invade the lymphatic system causing lymphangitis ("pinarim") and mild elephantiasis, usually limited to the lower extremities. Low-level rural foci exist in the southern coastal provinces. Isolated foci are known from the cities of Yongju, Kwangju and Pusan. Considered endemic throughout Cheju-do. Microfilarial infection rates range from 3-17% in inland foci to 7-30% on Cheju-do. The average infection rate increases with age from 2% in those 5-9 years old to 14% in people over 60. Many people with microfilaremia show no clinical symptoms. The elephantiasis rate on Cheju-do may be as high as 3%.

VECTOR TRANSMISSION: Bite of mosquitoes carrying infective third-stage larvae.

PRIMARY VECTORS: *Aedes togoi*
Anopheles sinensis
SECONDARY VECTOR: *Culex pipiens pallens*

VECTOR BIONOMICS: *Aedes togoi* (for *Anopheles sinensis* see MALARIA)

Breeds in rock pools with brackish tidal water and in artificial containers (earthenware jars, cisterns) of rain water from May through October, with population peaks in spring and fall. Adults are commonly taken indoors during daytime collecting on Cheju-do. Larvae may overwinter in containers on Cheju-do, a habit that has been confirmed in Japan.

NOXIOUS PESTS OF KOREA

ARANEAE (spiders): *Chiracanthium* spp.: There are no records of systemic reactions to Korean spider bites, but those of three species of *Chiracanthium* are very painful. Widow spiders (*Latrodectus* spp.) also occur throughout the Korean peninsula.

CHILOPODA (centipedes): *Scolopendra subspinipes mutilans*: Occasionally encountered in rural or undeveloped areas. One of the largest scolopendrids (200-230 mm), this is a dangerous species because its bite can cause the whole body to swell and the bite site remains painful for several days. Most other Korean centipedes can also inflict toxic and painful bites.

COLEOPTERA (beetles): Meloidae (blister beetles): Painful blisters form after crushing these beetles against the skin. Though 19 species occur in the ROK, they are rare and are not attracted to lights. Carabidae (bombardier beetles): Members of the genus *Brachinus* are capable of squirting irritating benzoquinones into the eyes of attackers to a distance of 10 cm. Three rare species are known from the ROK.

HYMENOPTERA (bees, wasps, hornets): The number of stinging Hymenoptera in the ROK is small, and stings are serious only when complicated by anaphylactic shock.

LEPIDOPTERA (Oriental tussock moth, *Euproctis flava*, Lymantriidae): Exposure to adult wing scales causes a severe, painful dermatitis consisting of rough and reddened skin patches that last for 5-10 days. Heavy infestations during adult emergence periods (mid-July through August) expose rural inhabitants and military personnel stationed along the DMZ to large numbers of fluttering moths nightly. Army clinics in these areas have reported hundreds of cases of dermatitis during July and August. Inflammation of the eyes, nose and throat has also been reported. This moth is a real health problem because adults will converge on any lighted area. Larvae hibernate under bark or in forest litter.

VENOMOUS SNAKES

Agkistrodon halys (mamushi): This is the only poisonous snake on the Korean peninsula. A true pit viper (family Crotalidae), the mamushi is in the same genus as the North American copperhead. It is found in rocky or brushy habitats throughout the ROK and usually will not bite unless directly accosted or harassed. Its venom has one of the lowest toxicity values of all poisonous snakes, so most bites only result in painful localized swelling for 1-3 days. However, in rare cases the whole body may swell and the victim may experience nausea, dizziness, and dehydration. General supportive treatment should be administered. No necrosis of the bitten area occurs.

Hydrophis cyanocinctus (annulated sea snake), *Lapemis hardwickii* (Hardwicke's sea snake), *Pelamis platurus* (pelagic sea snake): All three of these poisonous snakes may be expected in coastal waters around the Korean peninsula, though the pelagic sea snake also occurs far out in the open ocean. Sea snakes are generally even tempered and will usually avoid swimmers. Bites result when the snakes are accidentally trampled or brushed against or when they are carelessly removed from nets, traps, or fishing gear. When stranded on beaches, they cannot strike but may turn to make an awkward snapping bite. Such bites are usually characterized by multiple pinhead-sized puncture wounds, in some of which broken teeth may be found. Of the three Korean species, *H. cyanocinctus* is by far the most venomous, followed by *L. hardwickii* and *P. platurus*. Envenomization entails little or no localized pain but often tenderness and pain in the larger skeletal muscles. Sweating and thirst are common complaints, as is respiratory distress in severe cases.

SNAKE BITE: Reported cases of snake bite in military personnel conducting operations are small; however, the fear of being bitten by a poisonous snake can be a degrading morale factor.

Laboratory experiments show that snake venoms contain a complex mixture of toxic factors, but the clinical signs of snakebite poisoning in humans are usually distinctive because viper venom is mainly vasculotoxic. Venomous snakes inflict two types of bite: (1) a bite inflicted when the snake is seeking prey, in which a victim dies rapidly following injection of a large quantity of venom, and (2) a defensive bite, with little or no venom injected, the snake's object being to escape. Studies of snakebite patients confirm that when venomous snakes bite humans, the bites nearly always are of the second type. More than half the victims have minimal or no poisoning. Only about a quarter will develop serious systemic poisoning.

The commonest reaction following snakebite, whether or not the snake is poisonous, is fright. Fear, to some degree, is present in all snakebite victims and often dominates the clinical picture. Emotional symptoms emerge rapidly, within minutes of the injury, while symptoms of systemic poisoning rarely appear until a half hour or more after the bite. The frightened victim may appear semiconscious, with cold, clammy skin, feeble pulse, and rapid, shallow breathing. These symptoms resolve quickly after a placebo injection.

FIRST AID: The following steps should be taken if snakebite occurs:

(1) Get the victim away from the snake. Keep the victim calm and quiet. Do not handle the snake or put yourself at risk of being bitten. Identify the snake if possible. If it has been killed, keep it.

(2) Immobilize the affected limb and apply direct pressure or compression over bite. Use no tourniquets. If possible, keep the site below the level of the victim's heart. Note: incision and suction of bite wound often is ineffectual in removing venom, and may even enhance inoculation of cobra-like venoms.

(3) Don't give the victim anything to eat or drink.

(4) If the bite is on one of the victim's upper limbs, remove any rings or jewelry from that limb.

(5) Arrange immediate evacuation of the victim. If there is no evidence of venom, keep the victim quiet and under observation.

(6) An ice pack can be used intermittently to reduce pain. DO NOT pack a limb in ice or immerse it in ice water.

For information on snakebite, including sources of antivenins worldwide, contact the Arizona Poison and Drug Information Center, phone (602) 626-6016. In addition to in-house expertise on North American pit vipers, the Center maintains a database of venomous snakes and their antivenins from around the world.

APPENDIX A. MOSQUITOES OF KOREA

Family Culicidae

Subfamily Anophelinae

Anopheles (*Anopheles*)
- *An. koreicus* Yamada & Watanabe
- *An. lesteri* Baisas & Hu
- *An. lindesayi japonicus* Yamada
- *An. pullus* Yamada
- *An. sinensis* Wiedemann
- *An. sineroides* Yamada
- *An. yatsushiroensis* Miyazaki

Subfamily Culicinae

Aedes (*Aedes*)
- *Ae. esoensis* Yamada

Aedes (*Aedimorphus*)
- *Ae. alboscutellatus* (Theobald)
- *Ae. vexans nipponii* (Theobald)

Aedes (*Edwardsaedes*)
- *Ae. bekkui* Mogi

Aedes (*Finlaya*)
- *Ae. alektorovi* Stackelberg
- *Ae. hatorii* Yamada
- *Ae. japonicus japonicus* (Theobald)
- *Ae. koreicus* (Edwards)
- *Ae. nipponicus* LaCasse & Yamaguti
- *Ae. oreophilus* (Edwards)
- *Ae. seoulensis* Yamada
- *Ae. togoi* (Theobald)

Aedes (*Neomelaniconion*)
- *Ae. lineatopennis* (Ludlow)

Aedes (*Ochlerotatus)*
- *Ae. dorsalis* (Meigen)

Aedes (*Stegomyia)*
- *Ae. albopictus* (Skuse)
- *Ae. chemulpoensis* Yamada
- *Ae. flavopictus* Yamada
- *Ae. galloisi* Yamada

Armigeres (*Armigeres*)
- *Ar. subalbatus* (Coquillett)

Coquillettidia (*Coquillettidia*)
- *Cq. ochracea* (Theobald)

Culex (*Barraudius*)
- *Cx. modestus inatomii* Kamimura & Wada

Culex (*Culex*)
- *Cx. bitaeniorhynchus* Giles
- *Cx. jacksoni* Edwards
- *Cx. mimeticus* Noe
- *Cx. orientalis* Edwards
- *Cx. pipiens pallens* Coquillett
- *Cx. pipiens quinquefasciatus* Say
- *Cx. pseudovishnui* Colless
- *Cx. sinensis* Theobald
- *Cx. sitiens* Wiedemann
- *Cx. tritaeniorhynchus* Giles
- *Cx. vagans* Wiedemann
- *Cx. whitmorei* (Giles)

Culex (*Culiciomyia)*
- *Cx. kyotoensis* Yamaguti & LaCasse
- *Cx. sasai* Kano, Nitahara & Awaya

Culex (*Eumelanomyia*)
- *Cx. hayashii* Yamada

Culex (*Lutzia*)
- *Cx. fuscanus* Wiedemann
- *Cx. halifaxii* Theobald

Culex (*Neoculex*)
- *Cx. rubensis* Sasa & Takahashi

Culiseta (*Culicella*)
- *Ct. nipponica* LaCasse & Yamaguti

Culiseta (*Culiseta*)
- *Ct. bergrothi* (Edwards)

Heizmannia (*Heizmannia*)
- *He. lii* Wu

Mansonia (*Mansonioides*)
- *Ma. uniformis* (Theobald)

Toxorhynchites (*Toxorhynchites*)
- *Tx. christophi* (Portschinsky)

Tripteroides (*Tripteroides*)
- *Tp. bambusa* (Yamada)

APPENDIX B. FLEAS OF KOREA

Family Amphipsyllidae

Ctenophyllus armatus (Wagner)
Paradoxopsyllus curvispinus Miyajima & Koidzumi

Family Ceratophyllidae

Amalaraeus andersoni ioffi (Darskaya)

Ceratophyllus
- *C. anisus* (Rothschild)
- *C. indages* (Rothschild)
- *C. tribulis* Jordan

Nosopsyllus
- *N. fasciatus* (Bosc)
- *N. nicanus* Jordan

Paraceras melis (Walker)

Family Hystrichopsyllidae

Ctenophthalmus
- *C. congeneroides* Wagner
- *C. pisticus pacificus* Ioff & Scalon

Doratopsylla coreana Darskaya

Hystrichopsylla microti Scalon

Nearctopsylla ioffi Sychevsky

Neopsylla
- *N. bidentatiformis* (Wagner)
- *N. specialis* Jordan

Palaeopsylla
- *P. mogura* Sakaguti & Jameson
- *P. sinica* Ioff

Rhadinopsylla
- *R. concava* Ioff & Tiflov
- *R. insolita* Jordan
- *R. valenti* Darskaya

Stenoponia
- *S. montana* Darskaya
- *S. sidimi* Marikovsky

Family Ischnopsyllidae

Ischnopsyllus
- *I. comans* Jordan & Rothschild
- *I. needhami* Hsu
- *I. obscurus* (Wagner)

Nycteridopsylla sakaguti Jameson & Suyemoto

Family Leptopsyllidae

Leptopsylla segnis (Schonherr)

Peromyscopsylla hamifer cuneata Johnson & Traub

Family Pulicidae

Ctenocephalides canis (Curtis)

Pulex irritans Linnaeus

Xenopsylla cheopis (Rothschild)

APPENDIX C. TICKS OF KOREA

Family Argasidae
- *Argas* (*Argas*)
  - *A. japonicus* Yamaguti, Clifford & Tipton
- *Argas* (*Carios*)
  - *A. vespertilionis* (Latreille)
- *Argas* (*Chiropterargas*)
  - *A. boueti* Roubaud & Colas-Belcour

Family Ixodidae
- *Boophilus*
  - *B. microplus* (Canestrini)
- *Dermacentor*
  - *D. coreus* Itagaki & Noda
- *Haemaphysalis* (*Haemaphysalis*)
  - *H. concinna* Koch
  - *H. flava* Neumann
  - *H. japonica* Warburton
- *Haemaphysalis* (*Kaiseriana*)
  - *H. longicornis* Neumann
- *Ixodes* (*Eschatocephalus*)
  - *I. vespertilionis* Koch
- *Ixodes* (*Ixodes*)
  - *I. granulatus* Supino
  - *I. persulcatus* Schulze
- *Ixodes* (*Ixodiopsis*)
  - *I. pomerantzevi* Serdyukova
- *Rhipicephalus*
  - *R. sanguineus* (Latreille)

APPENDIX D. CHIGGERS OF KOREA

Family Leeuwenhoekiidae

- *Shunsennia*
  - *S. gracilis* Ah
  - *S. hertigi* Traub, Morrow & Lipovsky
  - *S. tarsalis* Jameson & Toshioka

Family Trombiculidae
- Subfamily Gahrliepiinae
- *Walchia*
  - *W. comataxilla* (Traub, Morrow & Lipovsky)
- Subfamily Trombiculinae
- Tribe Schoengastiini
- *Ascoschoengastia*
  - *A. arcaricola* (Traub, Morrow & Lipovsky)
- *Eltonella*
  - *E. ichikawai* (Sasa)
  - *A. kitajimai* (Fukuzumi & Obata)
- *Cheladonta*
  - *C. ikaoensis* (Sasa, Sawada, Kano, Hayashi & Kumada)
- *Euschoengastia*
  - *E. koreaensis* Jameson & Toshioka
- *Helenicula*
  - *H. miyagawai* (Sasa, Kumada & Miura)
- *Neoschoengastia*
  - *N. asakawai* Fukuzumi & Obata
  - *N. posekanyi* Wharton & Hardcastle

Leptotrombidium
L. gemiticulum (Traub, Morrow & Lipovsky)
L. halidasys (Traub, Morrow & Lipovsky)
L. hiranumai (Kanda)
L. myoti (Ewing)
L. orientale (Schluger)
L. pallidum (Nagayo, Mitamura & Tamiya)
L. palpale (Nagayo, Mitamura & Tamiya)
L. pumile (Traub, Morrow & Lipovsky)
L. scutellare (Nagayo, Mitamura, Tamiya & Tenjin)
L. subakamushi (Schluger)
L. subintermedium (Jameson & Toshioka)
L. tectum (Traub, Morrow & Lipovsky)
L. zetum (Traub, Morrow & Lipovsky)

Microtrombicula
M. kyongkiensis Ah
M. loomisi Ah
M. miniopteri Ah
M. pipistrelli Ah

Neotrombicula
N. dubinini (Schluger)
N. gardellai (Kardos)
N. japonica (Tanaka, Kaiwa, Teramura & Kogaya)
N. mitamurai (Sasa, Hayashi, Kumada & Teramura)
N. nagayoi (Sasa, Hayashi, Sato, Miura & Asahina)
N. pomeranzevi (Schluger)
N. southardi (Kardos)
N. talmiensis (Schluger)
N. tamiyai (Philip & Fuller)

Sasatrombidium
S. koomori (Sasa & Jameson)

APPENDIX E. SYNANTHROPIC FLIES OF KOREA

Family Muscidae
Dichaetomyia
D. japonica Hori & Kurashasi

Fannia
F. canicularis (Linnaeus)
F. prisca Stein
F. scalaris (Fabricius)

Graphomya
G. maculata (Scopoli)
G. rufitibia Stein

Hydrotaea
H. occulta (Meigen)

Lispe
L. orientalis Wiedemann

Megophyra
O. leucostoma (Wiedemann)

Orthellia
O. coerulea (Wiedemann)

Phaonia
P. crassipalpis Shinonaga & Kano

Pyrellia
P. cadaverina (Linnaeus)
M. multisetosa Shinonaga

Morellia
M. saishuensis Ouchi

Musca
M. bezzii Patton & Cragg
M. conducens Walker
M. domestica Linnaeus
M. hervei Villeneuve
M. sorbens Wiedemann
M. tempestiva Fallen

Muscina
M. angustifrons (Loew)
M. pascuorum (Meigen)
M. stabulans (Fallen)

Ophyra

Stomoxys
S. calcitrans (Linnaeus)

Family Calliphoridae

Aldrichina
A. grahami (Aldrich)

Calliphora
C. lata Coquillett

C. vomitoria (Linnaeus)

Chrysomya
C. pinguis (Walker)

Hemipyrellia
H. ligurriens (Wiedemann)

Lucilia
L. ampullacea Villeneuve
L. bazini Seguy
L. caesar (Linnaeus)
L. illustris (Meigen)
L. porphyrina (Walker)

Onesia
O. koreana Kurahashi & Park

Phaenicia
P. cuprina (Wiedemann)
P. sericata (Meigen)

Protocalliphora
P. azurea (Fallen)

Triceratopyga
T. calliphorides Rohdendorf

Family Sarcophagidae

Bercaca
B. hemorrhoidalis (Fallen)

Blaesoxipha
B. filipjevi (Rohdendorf)
B. katoi Park & Kano
B. litoralis Villeneuve

Boettcherisca
B. peregrina (Robineau-Desvoidy)

Helicophagella
H. melanura (Meigen)

Horisca
H. hozawai (Hori)

Parasarcophaga
P. albiceps (Meigen)
P. brevicornis (Ho)

APPENDIX F. PERSONAL PROTECTIVE MEASURES

Personal protective measures are the first line of defense against arthropod-borne disease and may be the only protection for military personnel in the field. Proper wearing of the uniform and appropriate use of repellents can provide high levels of protection against blood-sucking arthropods. The uniform fabric is a significant mechanical barrier to mosquitoes and other blood-sucking insects. The uniform should be worn to cover as much skin as possible if weather and physical activity permit.

When operating in tick-infested areas, pants should be bloused into boots to prevent access to the skin by crawling arthropods. Check yourself frequently when in tick-infested areas. Upon returning from such areas, remove all clothing and examine yourself for ticks. Infected ticks may require several hours of feeding before pathogens are transmitted. Therefore, personnel in tick-infested areas should check themselves frequently and remove ticks as soon as possible.

If ticks become attached, the simplest and best method of removal is a slow, steady pull with a pair of tweezers. Don't squeeze the body but grasp the tick where the mouthparts enter the skin and pull firmly until the tick is extracted. Be careful not to break off the mouthparts in the skin. Wipe the bite area with an antiseptic. If hands have touched the tick during removal, wash them thoroughly with soap and water or an antiseptic, since tick secretions may contain pathogens.

Newly developed repellents provide personnel with unprecedented levels of protection. An aerosol formulation of permethrin (NSN 6840-01-278-1336) can be applied to the uniform but not the skin according to label directions. This will provide the uniform material with both repellent and insecticidal properties that will be retained through five washings. An Individual Dynamic Absorption Application (IDAA) kit is also availble for the permethrin treatment of uniforms (NSN 6840-01-345-0237). This product enables an individual to treat one uniform, and includes, two tubes of permethrin, two treatment bags, two pieces of twine, one pair of gloves, and a black marking pen. The IDAA treatment will last the life of the uniform. A 40% permethrin emulsifiable concentrate (EC) (NSN 6840-01-334-2666) is available for treating uniforms, netting and tentage using a 2-gallon spayer. Uniforms treated with the 40% EC permethrin will have repellent and insecticidal properties for the life of the uniform. A new extended-duration repellent lotion of DEET (N, N diethyl-3-methyl-benzamide, formerly N, N-diethyl-m-toluamide) (NSN 6840-01-284-3982) has been developed to replace the 2 oz. bottles of 70% DEET in alcohol. The new formulation contains 34% active ingredient. It's less irritating to skin, has less odor, and is generally more acceptable to the user.

Together with proper wearing of the uniform, use of extended duration DEET on exposed skin and permethrin on uniform items has been demonstrated in laboratory and field studies to provide nearly 100% protection against a variety of blood-sucking arthropods. In addition, permethrin should be used to treat bednets and tentage according to the label. Detailed instructions on the proper use of personal protective items are provided in Army Environmental Hygiene Agency Technical Guide No. 174: Personal Protective Techniques Against Insects and Other Arthropods of Military Significance. Order this publication from DPMIAC.

APPENDIX G. CHEMICAL CONTROL OF PESTS AND VECTORS

More detailed recommendations for the selection and use of pesticides in field situations worldwide, during contingency operations or exercises, can be found in AFPMB Technical Information Memorandum (TIM) 24, "Contingency Pest Management Pocket Guide." This guide is a concise reference to National Stock Number (NSN)-listed pesticides and equipment available through DoD supply channels for contingency use. It covers intended uses, dosages, application methods, pesticide dilution formulas, and dispersal equipment. TIM 24 also provides information on surveillance, trapping, safety, personal protective equipment, air-transport of pesticides that don't meet transportation requirements, and US military points of contact overseas who can provide information on vector-borne disease control in their respective areas of the world. Copies of TIM 24, can be obtained free of charge from: Defense Pest Management Information Analysis Center, Armed Forces Pest Management Board, Forest Glen Section, WRAMC, Wash., DC 20307-5001, Telephone (301) 427-5365, DSN prefix: 291 FAX: 5466 BBS: 5121

APPENDIX H. DOCUMENTED CASES OF INSECTICIDE RESISTANCE IN

THE KOREAS

INSECT	INSECTICIDE
Anopheles sinensis	diazinon DDT dieldrin fenitrothion fenthion malathion
Aedes togoi	chlorpyriphos DDT fenthion
Culex pipiens pallens	DDT fenitrothion malathion
Culex tritaeniorhynchus	chlorpyriphos DDT dichlorvos dieldrin fenitrothion fenthion malathion temephos
Musca domestica	DDT dieldrin malathion
Cimex lectularius	DDT dieldrin
Pediculus h. humanus	DDT dieldrin lindane

APPENDIX I. USAEHA RECOMMENDED HANTAVIRUS CONTROL MEASURES

Avoidance of rodents and their excreta by decreasing the availability of food sources and nesting sites is the primary preventive strategy. Consult USAEHA Technical Guide 138, Guide to Commensal Rodent Control. Before conducting rodent exclusion or control in building interiors, fleas must be controlled in order to prevent transmission of plague bacteria to humans as fleas search for an alternate host. Use an EPA-registered insecticide and always follow label instructions.

Rodent infestation can be determined by observation or inferred from droppings or evidence of gnawing at food. Exclude rodents from entering structures by covering all openings larger than one quarter of an inch with steel mesh screening, wood or cement. Discourage nesting by disposing of trash and clutter, moving woodpiles, and cutting grass, brush and dense shrubbery in a 100-foot perimeter around structures. Three inches of gravel under the base of elevated structures will also prevent burrowing.

Rodents do not stay where they do not have access to food and water. Keep food covered in rodent-proof metal or thick plastic containers with heavy lids. Keep pet food and water covered and stored in rodent-proof containers. Wash dishes and cooking utensils immediately, remove spills, and store garbage and utensils in rodent-proof containers.

Trap rodents by using snap traps placed in pairs, with triggers facing away from each other, parallel to walls in rodent runways (mousetrap, spring, NSN 3740-00-252-3384 per dozen; rat trap, spring, NSN 3740-00-260-1398 per dozen). Suspected runway locations can be confirmed by the presence of tracks in talcum powder.

Dispose of rodents caught in traps by first spraying the rodent and trap with a general purpose household disinfectant or bleach solution (3 tablespoons of household bleach in 1 gallon of water.) Next, place the trap and rodent directly into a plastic bag. Seal the bag and place it sealed-end-first (upside down) in another plastic bag and seal. Dispose of the bag in accordance with country guidelines.

Pest control workers and others **WITH FREQUENT RODENT CONTACT** in affected areas should be instructed in preventive measures, symptoms of disease, and when to seek medical attention. Workers should always wear protective clothing when handling traps containing rodents: rubber or plastic gloves, coveralls, rubber boots or disposable shoe covers, protective goggles, and a respiratory protection device such as a half-mask air-purifying (or negative pressure) respirator with a high-efficiency particulate air (HEPA) filter. Disposable protective gear and respirator filters should be discarded at the completion of work by placing them into a bag containing disinfectant solution. High efficiency particulate air prefilters, HEPA canister filters and HEPA disposable respirators should be handled on a one-use/one-time basis. If coveralls are not disposable, they should be kept in disinfectant until they can be laundered.

Others who may become exposed to Hantavirus include facilities engineers, house-keeping workers, plumbers, carpenters, insulation workers, telephone repair and installation workers, and warehouse personnel. Currently, there is insufficient information available to make general recommendations to all workers with potential exposure, other than that they avoid disrupting rodents or droppings.

The following is a list of HEPA respirators and HEPA canister filters with National Stock Numbers available as part of the Paperless Ordering Placement System (POPS). This information should provide cost-effective equipment for personnel requiring respiratory protection for potential Hantavirus exposure.

RESPIRATORS AND HEPA FILTERS AVAILABLE THROUGH THE PAPERLESS ORDER PLACEMENT SYSTEM (POPS)

Disposable Respirators

NSN No. 4240-01-272-1876 (size Medium)
4240-01-272-1877 (size Large)
Model - 3M** 9970 High Efficiency Respirator
High Efficiency Pre-Filter for 3M 5000 and 6000 Series Respirators

NSN No.4240-01-320-1954
Model - 2040 HEPA prefilter (may require purchase with the following Prefilter Adaptor)

NSN No. 4240-01-320-1956
Model - 502 Prefilter Adaptor
High Efficiency Filters for MSA+ Comfo II, Ultra Twin, and Belt Mounted Respirators (note: combination HEPA and specific contaminant cartridges are also available; consult manufacturer for specific NSN numbers)

NSN No. 4240-01-230-6894
Model MSA Type H HEPA filter cartridge
(note: combination HEPA and specific contaminant cartridges are also available; consult manufacturer for specific NSN numbers)

Reusable Respirators

NSN No. 4240-01-342-5237 (size Small)
Model - 6140 3M HEPA Respirator (6000 Series)

NSN No. 4240-01-342-5238 (size Medium)
Model - 6240 3M HEPA Respirator (6000 Series)

NSN No. 4240-01-342-2855 (size Large)
Model - 6340 3M HEPA Respirator (6000 Series)

High Efficiency Pre-Filters for 3M 7000 Series Respirators

NSN No. 4240-01-320-1954 (size Large)
Model - 2040 HEPA Prefilter (may require purchase with one of the following Prefilter Holders)

NSN No. 4340-01-320-1958
Model - 9286 Half Mask Holder

NSN No. 4240-01-320-1955
Model - 9891 Full Facepiece Holder

NSN No. 4240-01-246-5411
Model - 7255 High Efficiency Filter (may require purchase with the following Retainer)

NSN No. 4240-01-231-7718
Model - 7288 High Efficiency Filter Retainer

Powered Air Purifying Respirator (PAPR)

NSN No. 4240-01-301-4364
Model - 3M PES6 Whitecap PAPR 7800S(L)

Filters for PAPRs

NSN No. 4240-01-301-4379
Model - 3M High Efficiency Filter for 3M Whitecap W-3200 PAPR

NSN No. 4240-01-310-8874
Model - Racal P3 High Efficiency Filter for Breath Easy PAPR

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