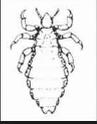




Office of the Deputy Under Secretary of Defense for Environmental Security



Regional Disease Vector Ecology Profile Central Europe



**Defense Pest Management Information Analysis Center
Armed Forces Pest Management Board
Forest Glen Section
Walter Reed Army Medical Center
Washington, DC 20307-5001**

Homepage: <http://www.afpmb.org>

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PREFACE

Disease Vector Ecology Profiles (DVEPs) summarize unclassified literature on medically important arthropods, vertebrates and plants that may adversely affect troops in specific countries or regions around the world. Primary emphasis is on the epidemiology of arthropod-borne diseases and the bionomics and control of disease vectors. DVEPs have proved to be of significant value to commanders, medical planners, preventive medicine personnel, and particularly medical entomologists. These people use the information condensed in DVEPs to plan and implement prevention and control measures to protect deployed forces from disease, injury, and annoyance caused by vector and pest arthropods. Because the DVEP target audience is also responsible for protecting troops from venomous animals and poisonous plants, as well as zoonotic diseases for which arthropod vectors are unknown, limited material is provided on poisonous snakes, noxious plants, and diseases such as hantavirus.

In this document vector-borne diseases are presented in two groups: those with immediate impact on military operations (incubation period < 15 days) and those with delayed impact on military operations (incubation period > 15 days). For each disease, information is presented on military importance, transmission cycle, vector profiles, and vector surveillance and suppression.

Additional information on venomous vertebrates and noxious plants is available in the Armed Forces Medical Intelligence Center's (AFMIC) Medical, Environmental, Disease Intelligence, and Countermeasures (MEDIC) CD-ROM.

Contingency Operations Assistance: The Armed Forces Pest Management Board (AFPMB) is staffed with a Contingency Liaison Officer (CLO), who can help identify appropriate DoD personnel, equipment, and supplies necessary for vector surveillance and control during contingencies. Contact the CLO at Tel: (301) 295-8312, DSN: 295-8312, or Fax: (301) 295-7473.

Defense Pest Management Information Analysis Center (DPMIAC) Services: In addition to providing DVEPs, DPMIAC publishes Technical Information Bulletins (TIBs), Technical Information Memorandums (TIMs), and the Military Pest Management Handbook (MPMH). DPMIAC can provide online literature searches of databases on pest management, medical entomology, pest identification, pesticide toxicology, and other biomedical topics. Contact DPMIAC at Tel: (301) 295-7476, DSN: 295-7476, or Fax: (301) 295-7483. Additional hard copies or diskettes of this publication are also available.

Other Sources of Information: The epidemiologies of arthropod-borne diseases are constantly changing, especially in developing countries undergoing rapid growth, ecological change, and/or large migrations of refugee populations resulting from civil strife. In addition, diseases are underreported in developing countries with poor public

health infrastructures. Therefore, DVEPs should be supplemented with the most current information on public health and geographic medicine. Users may obtain current disease risk assessments, additional information on parasitic and infectious diseases, and other aspects of medical intelligence from the Armed Forces Medical Intelligence Center (AFMIC), Fort Detrick, Frederick, MD 21701, Tel: (301) 619-7574, DSN: 343-7574.

Disease Risk Assessment Profiles (DISRAPs) and Vector Risk Assessment Profiles (VECTRAPS) for most countries in the world can be obtained from the Navy Preventive Medicine Information System (NAPMIS) by contacting the Navy Environmental Health Center (NEHC) at Tel: (757) 762-5500, after hours at (757) 621-1967, DSN: 253-5500, or Fax: (757) 444-3672. Information is also available from the Defense Environmental Network and Information Exchange (DENIX). The homepage address is: <<http://denix.army.mil/denix/denix.html>>.

Specimen Identification Services: Specimen identification services and taxonomic keys can be obtained from the Walter Reed Biosystematics Unit (WRBU), Museum Support Center, MRC-534, Smithsonian Institution, Washington, DC 20560 USA; Tel: (301) 238-3165; Fax: (301) 238-3667; e-mail: <wrbu@wrbu.si.edu>; homepage: <<http://wrbu.si.edu/>>.

Emergency Procurement of Insect Repellents, Pesticides and Equipment: Deploying forces often need pesticides and equipment on short notice. The Defense Logistics Agency (DLA) has established the following Emergency Supply Operations Centers (ESOCs) to provide equipment and supplies to deploying forces:

For insect repellents, pesticides and pesticide application equipment: Contact the Defense Supply Center Richmond ESOC at Tel: (804) 279-4865, DSN: 695-4865. The ESOC is staffed seven days a week/24 hours a day. Product Manager (804) 279-3995, DSN: 695-3995.

For personal protection equipment (bednets, headnets, etc.) and respirators: Contact the Defense Supply Center Philadelphia ESOC Customer Assistance Branch at Tel: (215) 737-3041/3042/3043, DSN: 444-3041/3042/3043.

Every effort is made to ensure the accuracy of the information contained in DVEPs. Individuals having additional information, corrections, or suggestions, are encouraged to provide them to the Chief, DPMIAC, Armed Forces Pest Management Board, Forest Glen Section, Walter Reed Army Medical Center, Washington, DC 20307-5001, Tel: (301) 295-7476, DSN: 295-7476, or Fax: (301) 295-7482.

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EXECUTIVE SUMMARY

Central European Profile

Geography. Central Europe encompasses slightly more than 1.45 million sq km of land. From north to south, its topography varies from flat marshy plains along the Baltic Sea, through open plains, rolling hills, the eastern Alps and Carpathian Mountains, the broad upland valleys drained by the Danube River, the rugged crests and steep narrow valleys of the Balkan Mountains, and over 2,000 Greek islands in the Aegean and Mediterranean Seas. Each of the 16 countries in the region is geographically unique, as exemplified by Hungary's broad, flat, fertile valley, bordered on one side by mountains; Romania's combination of mountains and rolling plains; Macedonia's extensively rugged mountains; and the thousands of islands of Greece. The highest peak in this region is Mt. Musala, at 2,925 m, in the Rhodope Mountains of southwestern Bulgaria. The lowest point is a depression at Raczk Elblaskie, at -2 m elevation, about 50 km southeast of the Polish port city of Gdansk. Many peaks and ridges in the Alps, Carpathian and Balkan Mountains remain snow-capped during much of the year. Central Europe is bordered on the north by the Baltic Sea and Russia; on the east by Russia, the Ukraine, Moldova, the Black Sea, and Turkey; on the south by the Adriatic and Mediterranean Seas; and on the west by Germany, Austria, Italy and the Adriatic Sea. This area has been a crossroads of trade, travel and military activity throughout recorded history. The economies of the region are based on minerals, petroleum, coal and agriculture. Greece and Croatia have significant fishing industries, and Greece is very important in world shipping. Tourism is an important source of income for several Central European countries. The states that formerly constituted Yugoslavia have suffered severe disruption of their infrastructures and economies since 1992 because of bitter ethnic fighting, despite intervention by international mediators and peacekeeping forces. Serbia and Montenegro, Bosnia and Herzegovina, and Croatia have suffered the most destruction. Over half the countries in Central Europe must import most of their energy resources, food and/or raw materials. Many are heavily dependent on foreign aid and foreign investment.

Climate. The climate of Central Europe can be generally described as continental, with cold wet winters and warm moist summers, or Mediterranean, with cool wet winters and hot dry summers. The climate in any particular country depends on its proximity to major mountains or large bodies of water, its elevation, and local topography. Coastal lowlands tend to have moderate, moist conditions year-round, while steep valleys at higher elevations tend to be cooler and drier, especially when they are on the lee side of prevailing weather patterns. In the southernmost countries, it can be very hot in mid-summer at lower elevations, especially on southeast-facing slopes. Wind and weather patterns tend to travel from west to east across this area, but local direction, moisture content, and temperature extremes can often be greatly modified by mountains or large bodies of water.

Population and Culture. Central Europe has a population of approximately 140 million people. Most have a long history of ethnic pride, passionate feelings, and great awareness of their ancestry and cultural background. The ethnic make-up, religious mix and culture of each country may vary greatly over short distances. In Bosnia and Herzegovina, roughly 40% of the people claim to be Serbs, 38% are Muslims, and 22% are Croats. In most Central European countries, one ethnic group accounts for more than half the population. The people of Central Europe practice many different religions. About 43% are Roman Catholics, 33% are Eastern (or Russian) Orthodox, and about 6% are Muslims (mainly of the Sunni sect). At least five Protestant denominations in addition to Judaism and other religions are practiced by the remaining 18% of the population. These Central European countries have become more urbanized, especially since World War II and the collapse of Communism. All but three countries (Serbia and Montenegro, Albania, and Slovenia) are at least 50% urbanized. Most people live on a relatively small portion of the land, mainly in or near larger cities, which have better access to transportation and other resources. Urban areas are concentrated along major rivers, in fertile valleys, or near the coast. Large cities, such as Warsaw, Prague, Bucharest and Budapest, often have many old, deteriorating buildings that are unfit for habitation. Many cities and towns in Bosnia and Herzegovina, Croatia, and Serbia and Montenegro have been extensively destroyed in ethnic fighting, and refugees from those conflicts have crowded into nearby countries, severely straining their resources. Two poorly developed and neighboring countries, Albania and Macedonia, both impoverished and with mainly agricultural economies, have been nearly overwhelmed by the refugee burden. This displacement, along with associated poor sanitation and crowding, provides excellent conditions for the spread of vector-borne and infectious diseases. Before the ethnic conflicts, population densities in Central European countries varied from a low of 81 persons per sq km in Bulgaria to a high of 131 persons per sq km in the Czech Republic. Despite their turbulent history, the vast majority of the people in all these countries are literate, with 11 countries having literacy rates of at least 97%.

Sanitation and Living Conditions. Sanitation and living conditions throughout the region are barely adequate by Western standards. Septic and sewer systems are chiefly found in cities, and even these are often old, inadequate, and poorly maintained. Water treatment and distribution systems are few and limited (many serve less than 1/3 of their city), are seldom maintained, and frequent cross-connections result in contamination by fecal matter or industrial wastes. Waste disposal is indiscriminate in many areas, especially urban slums, where waste and refuse are sometimes piled into an empty apartment or an empty room in an otherwise fully occupied building. Food sanitation is poor, and vermin of various kinds are common in and near human habitations. Housing shortages in many cities have been made worse by an influx of refugees, and several families often share a small building. Areas with sanitary conditions degraded by civil war have rapidly increasing rodent populations. The potential for rodent-borne and louse-borne diseases under such crowded, unsanitary conditions is high. Many cities, streams and rivers, and even some extensive areas of soil, have been progressively contaminated by heavy metals and toxic chemicals as a result of decades of heavy

industrial activity, such as smelting, manufacturing, chemical production, and petroleum refining. Little or no effort has been made to minimize or prevent such pollution. Countries with serious industrial pollution include Poland, Croatia, Bosnia and Herzegovina, Hungary, the Czech Republic, and the Slovak Republic.

DIARRHEAL DISEASE

Gastrointestinal infections are moderately or highly endemic throughout Central Europe and are the principal disease threats to military personnel deployed to the region. Risk of transmission is generally higher in rural areas and during warm months of the year in less developed countries such as Albania, countries with declining socioeconomic standards, and areas of Yugoslavia with degraded sanitary conditions and large refugee populations due to civil war. It may take several years to rebuild the sanitary and public health infrastructures destroyed during the recent conflict. Outbreaks of typhoid fever have already been reported.

Fecal-oral transmission from person to person is common, but most infections are acquired from the consumption of contaminated food, water or ice. Filth flies can be important in the mechanical transmission of pathogens to food, food preparation surfaces and utensils. Fly populations sometimes reach very high levels during the summer in areas with poor sanitation. Strict sanitation and fly control can significantly reduce the risk of gastrointestinal infections. Cockroaches have also been shown to mechanically transmit gastrointestinal pathogens.

Bacteria and viruses causing diarrheal disease include: *Staphylococcus aureus*, *Clostridium perfringens*, *Bacillus cereus*, *Vibrio parahaemolyticus*, numerous serotypes of *Salmonella*, *Shigella* spp., *Campylobacter*, pathogenic strains of *Escherichia coli*, hepatitis A and E, rotaviruses and other viral species. Infection with pathogenic protozoa, such as *Entamoeba histolytica*, *Giardia lamblia* and *Cryptosporidium* spp., is common, though bacterial pathogens account for most cases of diarrheal disease. Onset of symptoms is usually acute and may result in subclinical infections or severe gastroenteritis. *Shigella* infections can produce significant mortality even in hospitalized cases. Resistance of enteric pathogens to commonly used antibiotics can complicate treatment. Such resistance is very common in many parts of Central Europe, and bacterial populations with resistance to multiple antibiotics have been reported.

Bacillary dysentery has had a profound impact on military operations throughout history. Gastroenteritis was epidemic in the Mediterranean, Middle Eastern and North African theaters during World War II.

TICK-BORNE DISEASE*

Tick-borne diseases are the most prevalent vector-borne diseases in Central Europe. Most are associated with periods of high tick activity, usually April through September, but regional differences and seasonal patterns may occur.

Tick-borne encephalitis is focally distributed with its primary vector, *Ixodes ricinus*, in mixed deciduous forests, extending into brushlands and meadows at the forest edge, including suburban forests bordering cities. Antibody prevalences up to 33% in humans and up to 92% in reservoir animals have been reported from active foci in Slovenia and Croatia. The Central European form of tick-borne encephalitis produces a milder illness than the Russian spring-summer encephalitis form found in Siberia, northeast China and Korea. Most infections are subclinical.

Lyme disease, also transmitted by *Ixodes ricinus*, is focally distributed throughout Central Europe in forested areas up to 1,500 m, and is the most common tick-borne infection in humans. Incidence of Lyme borreliosis has been increasing in the region. Antibody prevalences over 40% have been reported in forestry workers in Slovenia. Military personnel would have a high risk of exposure to these and other tick-borne diseases.

Tularemia, a plague-like disease caused by the bacterium *Francisella tularensis*, is widely distributed in Central Europe. Infection is acquired through the bite of infected hard ticks, by exposure to the blood or tissues of infected animals, or by consumption of insufficiently cooked meat of infected animals. Numerous wild mammals, especially rabbits and hares, and some domestic animals act as reservoirs.

Sporadic cases of **tick-borne relapsing fever** caused by *Borrelia recurrentis* are also reported throughout the region. The disease is enzootic in rocky, rural areas where livestock are tended and vector soft ticks, *Ornithodoros* spp., are found.

Crimean-Congo hemorrhagic fever infects domestic animals in nearly every country in the region and is widely distributed in discrete foci in agricultural and rural areas. Sporadic human cases occur. The disease can be contracted by the bite of infected *Hyalomma* ticks, but most human cases result from exposure to secretions or blood from infected animals or humans. Medical workers treating patients are at high risk of becoming infected. Clinical symptoms can be severe, with mortality rates up to 50%.

Q fever is an acute, febrile rickettsial disease contracted primarily by inhalation of airborne pathogens or contact with secretions of infected domestic animals. Transmission by ticks to humans is possible but rarely, if ever, occurs. Serological surveys indicate that Q fever is widespread throughout Central Europe and infects a wide variety of wild mammals and domestic animals, especially goats. Military personnel should avoid exposure to sheep, goats, cattle and other domestic animals and should not sleep or rest in animal shelters.

Boutonneuse fever (also termed Mediterranean spotted fever) transmitted by the brown dog tick, *Rhipicephalus sanguineus*, and other ixodid ticks is focally distributed, primarily in coastal areas. The risk of infection is elevated in cities and villages with

high populations of tick-infested dogs. Other *Rickettsia* of the spotted fever group have been isolated in several countries of Central Europe.

Bhanja virus is transmitted primarily by *Haemaphysalis* ticks in enzootic areas of Central Europe and causes a mild febrile illness in humans. Antibodies have been detected in a wide range of mammals, especially ruminants, and in several species of birds. Its distribution in Central Europe is unclear. Infections with Bhanja virus would have minimal military significance.

MITE-BORNE DISEASE*

Rickettsialpox, an acute febrile illness transmitted by mites, is caused by *Rickettsia akari*, a member of the spotted fever group of *Rickettsia*. Clinical symptoms mimic chickenpox and cases may be misdiagnosed. The house mouse, *Mus musculus*, and other commensal rodents are reservoirs. *Rickettsia akari* was isolated from a patient in Croatia in 1991; this was the first report of this disease in Central Europe in 40 years. Its presence in other areas of Central Europe is unclear, but the potential exists for outbreaks in the human population in areas of the former Yugoslavia disrupted by civil war.

LOUSE-BORNE DISEASE*

Epidemic typhus in the recrudescence form of Brill-Zinsser disease has been reported from several countries in Central Europe. During the period 1965 to 1975, 623 cases were reported from Bosnia and 107 from Serbia. Declining sanitary and living conditions caused by civil war in many areas of the former Yugoslavia have increased the incidence of head and body lice. The conditions faced by refugees and displaced persons, whether in collective centers or living independently in the community, are such that the likelihood of louse-borne disease is high.

Sporadic cases of **louse-borne relapsing fever** have also been reported from the region, and, like epidemic typhus, it is a winter disease.

FLEA-BORNE DISEASE*

Murine typhus is a rickettsial disease similar to louse-borne typhus but milder. It is enzootic throughout the region in domestic rats and mice and possibly other small mammals. Infected rat fleas (usually *Xenopsylla cheopis*) defecate infective rickettsiae while sucking blood. Airborne infections can occur. Sporadic human cases have been reported throughout Central Europe.

SAND FLY-BORNE DISEASE*

Cutaneous leishmaniasis, caused by *Leishmania tropica*, is present in the countries of Central Europe that border the Mediterranean and in a band that extends into Central Asia. *Leishmania tropica* is usually a parasite of man in urban environments and is transmitted by the sand fly *Phlebotomus sergenti* in Greece. The disease is also found in Albania, Bulgaria, the southern half of Romania, and in all of the newly formed countries of the former Republic of Yugoslavia except Slovenia. *Phlebotomus perfiliewi*, the

primary vector, is very tolerant of the hot summers and cold winters characteristic of these Central European countries. Man is the principal reservoir, but dogs have been found naturally infected.

Visceral leishmaniasis, caused by *Le. infantum*, is a less prevalent but more severe systemic disease. It generally occurs as foci in rural areas, but the highest incidence in Central Europe occurs in the suburbs of Athens and the Greek Isles. It is endemic in at least part of every country in Central Europe except Poland, the Czech Republic and Slovakia. The most common reservoirs are believed to be domestic dogs and wild canines, primarily foxes. *Phlebotomus neglectus* is the putative vector in Greece, but *P. perfiliewi*, *P. perniciosus*, *P. tobbi*, *P. simici* and *P. longiductus* may be significant vectors in many endemic areas of Central Europe. Transmission occurs during the warmer months of April through October, coinciding with the activity of vector sand flies. Phlebotomine sand flies bite from dusk to dawn but may feed during the day if hosts enter their resting habitat. The distribution of sand flies and the diseases they carry is very focal because of their limited flight capabilities.

Foci of **sand fly fever** occur primarily throughout the Adriatic coastal areas of Central Europe. This disease caused significant morbidity among Allied forces in the Mediterranean during World War II. The highest risk of transmission exists in villages and periurban areas. Local populations are generally immune as a result of childhood infection. The Naples, Sicilian and Toscan viruses circulate in endemic areas of Central Europe, but the Naples type predominates. Risk of infection is highest between May and October, when the sand fly vector, *Phlebotomus papatasi*, is most active. Humans are the reservoir of this debilitating disease, although small rodents are suspected reservoirs.

MOSQUITO-BORNE DISEASE*

There is virtually no risk of **malaria** in Central Europe. Malaria was eradicated from all countries by the 1970s with the exception of Greece, which was declared malaria-free in 1986. However, indigenous transmission of malaria in Greece may have occurred as late as 1991. The risk of transmission is greatest along the Turkish border, where *Plasmodium vivax* is highly endemic. All recent cases of malaria reported in Central Europe are imported. The number of imported cases, including drug-resistant strains of *P. falciparum*, has increased since the 1990s. Several species of competent vectors exist throughout the region, and *Anopheles* surveillance and control programs have been discontinued in many countries of Central Europe. Conditions for the reestablishment of malaria in the region are therefore favorable.

Several **mosquito-borne viruses** circulate in Central Europe. Serological surveys and viral isolates from mosquitoes indicate that **Sindbis** and **West Nile** viruses are widespread and probably enzootic in every country of the region. Europe's largest outbreak of West Nile fever occurred in Romania during 1996. **California group viruses** usually produce a mild febrile illness with headache and are transmitted primarily by *Aedes* mosquitoes. **Tahyna** virus is the most prevalent member of this viral

group in Central Europe. Cases of **dengue fever** have not been reported recently from Central Europe, although outbreaks have historically occurred in Greece, Albania and Bulgaria, where the primary vector *Aedes aegypti* is present. *Aedes albopictus* has become established in Italy, Albania and Greece, and many are concerned about its spread to other Mediterranean countries and its potential for involvement in arbovirus cycles in the region.

RODENT-BORNE DISEASE

Hantaviral diseases are an emerging public and military health threat. Field rodents are reservoirs for several closely related viruses that can be transmitted to humans exposed to airborne pathogens from dried rodent excreta. Serological evidence of hantaviral infection has been detected in humans and wild animals in every country of Central Europe. At least five serotypes of hantavirus that cause clinical disease in humans are present in the region. A severe form of the disease referred to as hemorrhagic fever with renal syndrome is caused by the Hantaan virus and is associated with the field mouse, *Apodemus agrarius*, in open field or unforested habitats. Death rates often exceed 10%. A milder disease, caused by the Puumala virus, is associated with the red bank vole, *Clethrionomys glareolus*, in woodland or forest-steppe habitats. Dobrava-Bulgaria virus is closely related to Hantaan virus and is associated with the yellow-necked field mouse, *Apodemus flavicollis*. The Seoul serotype infects *Rattus norvegicus*, and risk of infection occurs when living or working in dusty rat-infested buildings. Tula virus also circulates in the region, but its role in human disease is unclear. Outbreaks of hantaviral disease have frequently occurred in military personnel during field operations in the Balkans.

Leptospirosis should be considered enzootic in most countries of Central Europe. The spirochete is transmitted when skin or mucous membranes are contacted by water contaminated with urine of infected domestic and wild animals, especially rats. Military personnel would be at high risk of infection from this disease. Troops should never handle rodents and should not sleep or rest near rodent burrows or swim or bathe in stagnant pools or sluggish streams.

CONJUNCTIVITIS

Bacterial and viral **conjunctivitis** is common in Central Europe and has epidemic potential. Transmission is normally through contact with secretions of infected persons or contaminated articles. **Trachoma**, caused by the bacterium *Chlamydia trachomatis*, has become rare in most parts of Central Europe and most cases are imported. Eye gnats and flies can mechanically transmit these pathogens.

VENOMOUS ANIMALS

Only five species of venomous terrestrial **snakes** are found in Central Europe. Death from snakebite in the region is extremely rare, although the toxicity of venom and frequency of envenomization are significant. Military personnel should be thoroughly briefed on the risk and prevention of snakebite, as well as the steps to take immediately after snakebite. Effective antivenoms are available. **Scorpions, centipedes** and **widow**

spiders (*Latrodectus spp.*) are common in many parts of the region. Scorpion stings rarely require hospitalization, although *Latrodectus* envenomization can be life threatening. Troops should be warned not to tease or play with snakes and scorpions.

*** A properly worn Battle Dress Uniform (BDU) impregnated with permethrin, combined with use of extended duration DEET on exposed skin, has been demonstrated to provide nearly 100% protection against most blood-sucking arthropods. This dual use of highly effective repellents on the skin and clothing is termed the “DoD arthropod repellent system.” It is the most important single method of protecting individuals against arthropod-borne diseases. Permethrin can also be applied to bednets, tents and screens to help prevent disease transmission by insects. The proper use of repellents is discussed in TIM 36, Personal Protective Techniques Against Insects and Other Arthropods of Military Significance.**

VECTOR-BORNE DISEASES IN CENTRAL EUROPE* (+ = present; ? = uncertain)

Diseases	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
sand fly fever	+	?	+	+		+	+	+		+	+		+
West Nile virus	+	+	?	+	+	+	+	?	?	+	?	+	
Sindbis virus	?	+	?	+	+	+	+	?	?	?	?	+	
California viruses	?	+	?	+	+	?	+	?	?	?	+	+	
tick-borne encephalitis	+	+	+	+	+	+	+	+	+	+	+	+	+
Crimean-Congo hemorrhagic fever	+	+	+	+	+	+	+	+		+	+		
boutonneuse fever	+	+	+	+	+	+	+	?	?	+	+	+	+
rickettsialpox	?	?	?	+				?			?		
Q fever	+	+	+	+	+		+	+	+	+	+	+	+
tularemia	+	+	+	+	+		+	+		+	+	+	
tick-borne relapsing fever		?	+	+		+					+		?
Bhanja virus		+	+	?	+	?	+	+	?	+	+	+	+
ehrlichiosis			?										+
murine typhus	?	+	?	+	+	+		+		+			+

Diseases	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
epidemic typhus	?	+				?		?	+	?	+	?	
louse-borne relapsing fever	?	?		+				?					?
cutaneous leishmaniasis	+	+	+	+		+	+	?		+	+		?
visceral leishmaniasis	+	+	+	+		+	+	?		+	+		?
Lyme disease	+	+	+	+	+	?	+	+	+	+	+	+	+
leptospirosis	+	+	+	+	+	+	+	+	+	+	+	+	+
hantavirus	+	+	+	+	+	+	+	+	+	+	+	+	+

* ALB=Albania, BIH=Bosnia and Herzegovina, BGR=Bulgaria, HRV=Croatia, CZE=Czech Republic, GRC=Greece, HUN=Hungary, MKD=Macedonia, POL=Poland, ROM=Romania, SER=Serbia and Montenegro, SVK=Slovak Republic, SVN=Slovenia.

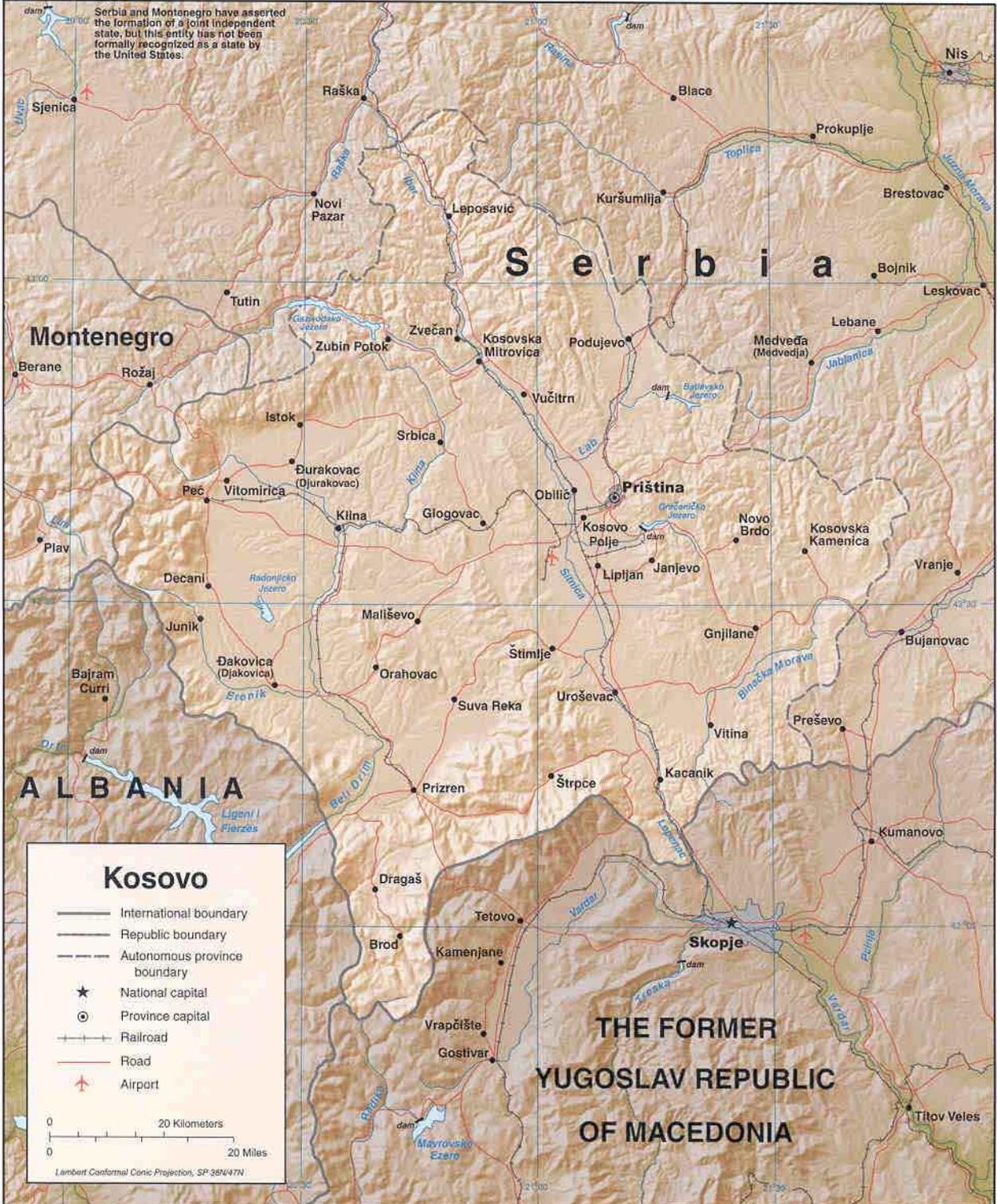
Europe



Central Balkan Region



Serbia and Montenegro have asserted the formation of a joint independent state, but this entity has not been formally recognized as a state by the United States.



Kosovo

- International boundary
- Republic boundary
- - - Autonomous province boundary
- ★ National capital
- ⊙ Province capital
- +—+—+— Railroad
- Road
- ✈ Airport

0 20 Kilometers
0 20 Miles

Lambert Conformal Conic Projection, SP 38N/47N

**THE FORMER
YUGOSLAV REPUBLIC
OF MACEDONIA**



Albania

- International boundary
- Republic boundary
- District (*rreth*) boundary
- ★ National capital
- ⊙ District (*rreth*) center
- Railroad
- Road

A district has the same name as its center except where noted.

0 20 Kilometers

0 20 Miles

Lambert Conformal Conic Projection, SP 40N/60W

Serbia and Montenegro have asserted the formation of a joint independent state, but this entity has not been formally recognized as a state by the United States.

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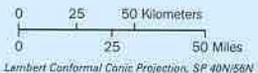
Serbia and Montenegro have asserted the formation of a joint independent state, but this entity has not been formally recognized as a state by the United States.

22 Serbia and Montenegro have asserted the formation of a joint independent state, but this entity has not been formally recognized as a state by the United States.





*Serbia and Montenegro have asserted the formation of a joint independent state, but this entity has not been formally recognized as a state by the United States.





Czech Republic

- International boundary
- Region (kraj) boundary
- ★ National capital
- ⊙ Region (kraj) capital
- +— Railroad
- Expressway
- Road

Prague is the capital of both Praha and Středočeský Regions.

0 25 50 75 Kilometers
0 25 50 75 Miles

Lambert Conformal Conic Projection, SP 40N/56N





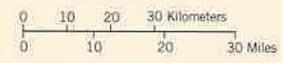


Serbia and Montenegro have asserted the formation of a joint independent state, but this entity has not been recognized as a state by the United States.

The Former Yugoslav Republic of Macedonia

- International boundary
- - - Republic boundary
- - - - Autonomous province boundary
- County (*opština*) boundary
- ★ National capital
- ⊙ Autonomous province capital
- ⊙ County (*opština*) capital
- +— Railroad
- Expressway
- Road

An *opština* has the same name as its capital except where noted. Skopje serves as capital for five counties.



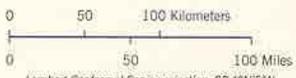
Lambert Conformal Conic Projection, SP 38N/47N



Poland

- International boundary
- Province (*województwo*) boundary
- National capital
- Province (*województwo*) capital
- Railroad
- Expressway
- Road

A province has the same name as its capital except where noted.



Lambert Conformal Conic projection, SP 40N/50N



SLOVAKIA

UKRAINE

HUNGARY

MOLDOVA

Serbia

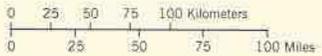
BULGARIA

Black Sea

Romania

- International boundary
- County (județ) boundary
- National capital
- County (județ) center
- Railroad
- Expressway
- Road

București is a municipality (municipii).



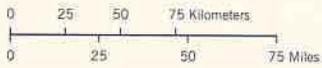
Lambert Conformal Conic Projection, SP 40N/58N

Serbia and Montenegro have asserted the formation of a joint independent state, but this entity has not been formally recognized as a state by the United States.

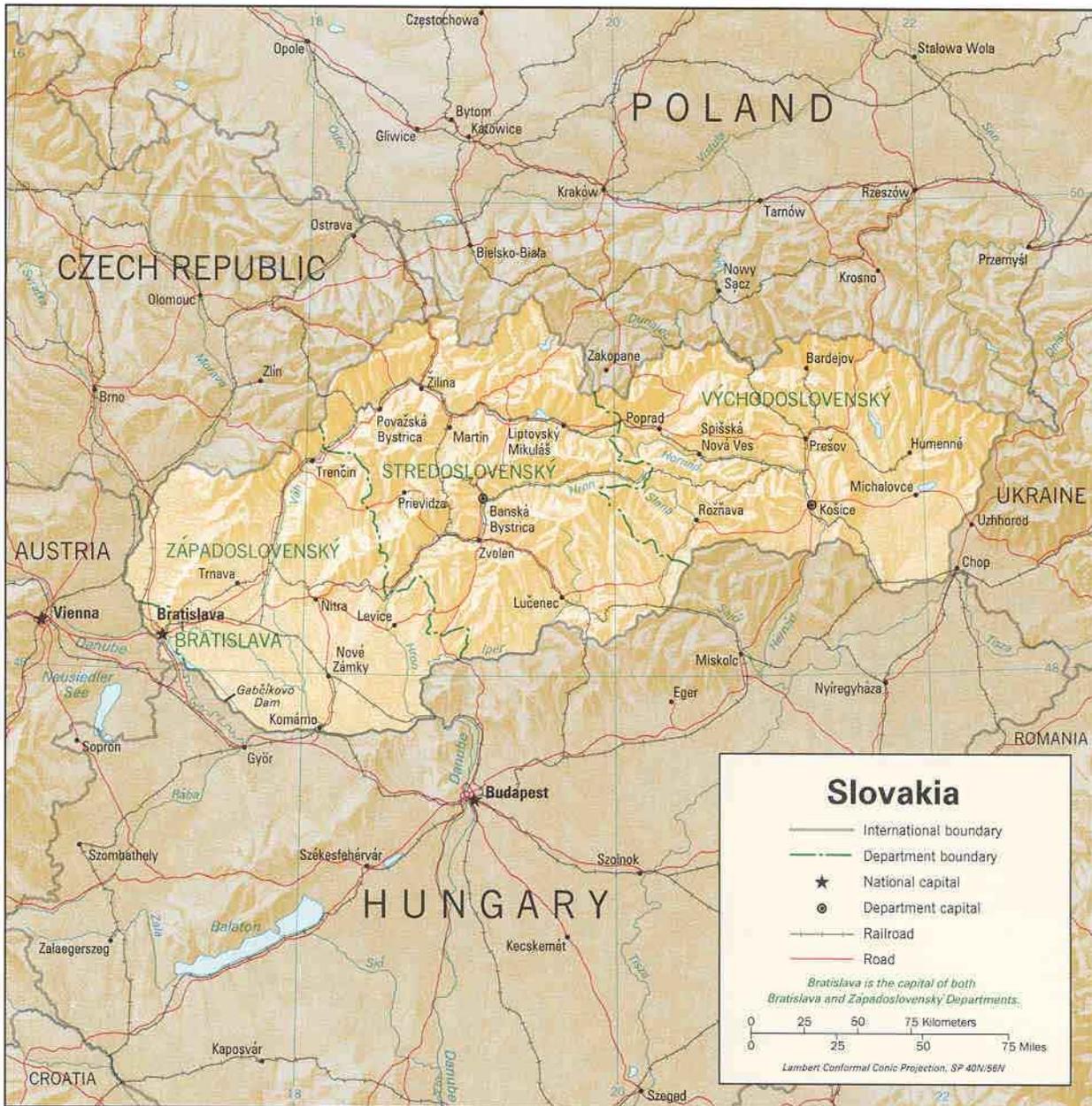


Serbia and Montenegro*

- International boundary
- Republic (*pokajine*) boundary
- Autonomous province boundary
- ★ National capital
- ☆ Republic (*pokajine*) capital
- ⊙ Autonomous province capital
- Railroad
- Expressway
- Road



*Serbia and Montenegro have asserted the formation of a joint independent state, but this entity has not been formally recognized as a state by the United States.



Slovakia

- International boundary
- Department boundary
- National capital
- Department capital
- Railroad
- Road

Bratislava is the capital of both Bratislava and Západoslovenský Departments.

0 25 50 75 Kilometers

0 25 50 75 Miles

Lambert Conformal Conic Projection, SP 40N/56W

IV. Country Profiles.

A. Albania.

1. Geography. Albania, about the size of Maryland, has a land area of 27,400 sq km, nearly 70% of which is mountainous. The country can be divided into two geographic regions: (1) The mountainous highland region consists of three mountain ranges. In the north, the rugged Albanian Alps run north-south with peak elevations of 2,700 m. The central highlands, with wide valleys and large lakes, are less rugged than the Alps, but reach a peak elevation of 2,750 m at Mt. Majae Korabit, the highest point in the country. This area occasionally experiences severe earthquakes. The mountains of the southern highland region have peaks from 2,100 to 2,400 m and continue into northern Greece. (2) The lowland region along the Adriatic Sea reaches 470 m elevation and generally extends inland about 16 to 48 km, but extends further along the river valleys. Much of the area consists of marshlands and eroded lowlands, but inland foothills have fertile soils. The rugged terrain, occasional earthquakes, and the risk of tidal waves along the southwestern coast are threats to humans living in Albania.

2. Climate. Albania's climate varies geographically and seasonally. In the highlands, cold northerly winds frequently cause frigid winters from November through March. Snow remains on the ground for several months and accumulates to average depths of 1,800 to 2,500 mm. Precipitation is heaviest from October through March. In the southern highlands, mean precipitation for November through January is about 1,000 mm. In the central highlands, thunderstorms and torrential downpours are common. The lowlands typically have mild, wet winters, with temperatures seldom falling below -8°C. In the lowlands, summers are hot and dry, with temperatures in July and August frequently rising above 38°C. Cyclones are common in winter. The cold weather at high elevations, and frequent severe storms, make much of Albania a physically demanding place to live or work outdoors.

Tirane (elevation 90 m)

Mean Daily Temperatures (°C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
MAXIMUM (°C)	11	12	15	18	23	28	31	31	27	23	17	14
MINIMUM (°C)	2	2	5	8	12	16	17	17	14	10	8	5

Monthly Precipitation (liquid equivalent)

MEAN (mm) 135 152 128 117 122 86 32 32 60 105 211 173

3. Population and Culture. Albania is mostly rural and economically undeveloped. It is one of Europe's poorest nations. Poor soil conditions and lack of water in some areas discourage settlement and severely limit food production. Poor nutrition makes the population less resistant to disease and environmental stress. The rugged terrain makes land transportation difficult and reduces access to many settlements that typically contain 70 to 100 households. The majority of the population lives on the coastal plain. Land use includes: 21% arable, 20% crops or pasture, and 38% forests or woodlands. Albania's ethnic makeup is about 95% Albanians, 3% Greeks and 2% other origins. Religious makeup is 70% Muslim, 20% Orthodox Christian and 10% Roman Catholic. The culture is traditionally male-dominated, and family, ethnic, and cultural ties are strong. Total population 3.3 million, 37% urbanized, literacy rate 72%.

4. Water, Living and Sanitary Conditions. Albania has abundant water resources. Principal sources include wells, springs, lakes, rivers, and streams. Average annual precipitation is the highest in Europe, but rainfall is unevenly distributed throughout the year, and drought has affected water supply in the lowlands. Water from urban and rural sources is frequently contaminated biologically and/or chemically. Even water from treated sources is suspect because of antiquated, ineffective or poorly maintained treatment and distribution systems. Water shortages are frequent, and broken and cracked water and sewage lines run close together, resulting in frequent cross-contamination. This provides excellent opportunities for the spread of many water-borne diseases and parasites. Leaking water systems assure ample breeding sites for disease vectors. Smaller communities and urban homes not connected to municipal water systems rely on private wells, cisterns and public fountains for water. Since these are frequently in poor condition, they are also a source water-borne disease. Water obtained from the karst area (limestone region with crevices and sink holes) east of Tirane lacks the brackish taste characteristic of coastal well water, but these sources can easily be contaminated through open karst fissures. Sanitation typically fails to meet Western standards. Public services cannot keep pace with the increasing amount of solid waste in urban areas. Most waste is simply dumped into the streets. Landfills are not organized to separate hazardous from nonhazardous waste. Albania has few urban sewage treatment systems. Rural residents rely on outdoor pit latrines and privies to dispose of excreta. Multiple family groups frequently live in the same dwelling because of housing shortages. This facilitates the spread of communicable diseases in a country where health care and medicines are very limited. Many homes lack potable water, electricity, and fuel for heating and cooking. Frequent food shortages, especially of fresh meats, eggs, and milk, result from inadequate storage, refrigeration and distribution systems. Hot and cold food-handling equipment is lacking. Gastrointestinal diseases are common due to poor sanitation and improper food handling. Large segments of the population, especially in urban areas, depend on humanitarian aid to meet basic food needs. Like

many Central European nations, Albania has numerous local pollution problems caused by industrial wastes, chemicals, or burning of low quality fuels. Sites that contain mercury, arsenic, petroleum, or highly acidic residues pose a significant public health threat.

B. Bosnia and Herzegovina.

1. Geography. Bosnia and Herzegovina is slightly larger than Tennessee and covers a land area of 51,200 sq km. It is landlocked except for a 20 km coastline on the Adriatic Sea. It is bordered on the north mainly by Croatia, on the west and southwest by Croatia and the Adriatic Sea, and on the east and southeast by Serbia and Montenegro. It is primarily mountainous with several peaks exceeding 1,900 m elevation. Lowlands with fertile soils are located in the north. The highest elevation in the country is a peak near Maglic (southeast of Sarajevo, near the border with Serbia and Montenegro) that reaches 2,386 m. During the past 30 years, Croatia has been subject to frequent destructive earthquakes.

2. Climate. Bosnia and Herzegovina have a continental climate that is warm in summer and cold in winter. In Sarajevo, temperatures have reached as low as -26°C in January and as high as 37°C in July and August. At high elevations, summers are short and cool, and winters are long and severe. Snow is frequent and remains on the ground for several months. Winters are mild and rainy along the Adriatic coast.

Sarajevo (elevation 520 m)												
Mean Daily Temperatures (°C)												
MONTH	J	F	M	A	M	J	J	A	S	O	N	D
MAXIMUM (°C)	2	6	10	14	20	22	25	25	22	16	8	3
MINIMUM (°C)	-5	-3	1	4	8	12	13	13	9	5	0	-4

Monthly Precipitation (liquid equivalent)												
MEAN (mm)	58	53	74	69	81	94	67	67	76	97	81	71

3. Population and Culture. Bosnia and Herzegovina is one of the least urbanized countries in Europe. Land use includes: 14% arable, 25% permanent crops or pasture, and 39% forests. Religious makeup is 40% Muslim, 31% Orthodox Christian, 15% Roman Catholic, 4% Protestant, and 1% other. The culture is traditionally male-dominated, and family, ethnic, and cultural ties are strong. The civil war that began in

1992 has severely disrupted much of the country's infrastructure, and many cultural and religious institutions have been destroyed. Large numbers of displaced persons and current reintegration efforts have significantly altered the ethnic makeup and population density. Before the war, the population's literacy rate was about 93%, but education has been seriously disrupted. Total population is 3.4 million. The current literacy rate and percent urbanized are unknown due to the civil war.

4. Water, Living and Sanitary Conditions. Major water sources include rivers, streams and wells. Water is perennially available throughout the country, except for the Karst areas of the coastal and interior highlands, and the terraces and sandy tracts of the eastern part of the northern plain. Surface water is most abundant from November through June. Large influxes of displaced persons are straining existing water supplies. Prewar water treatment and supply systems were old and in poor repair. During the conflict, these systems were extensively damaged. Lack of materials and qualified technicians prevent their repair. In Sarajevo, Zagreb and other cities, water treatment includes chlorination and filtration. However, inadequate supplies of treatment chemicals and intermittent pumping due to fuel shortages have resulted in unreliable water quality at the tap. Drinking water is frequently contaminated by fecal or industrial wastes. Since the signing of the Dayton Agreement, peacekeeping forces and many non-governmental organizations have been attempting to repair and improve water treatment and distribution systems to the indigenous population. However, the damage will take many years to repair. Bosnia and Herzegovina was one of the poorest republics in the former Yugoslavia. Since fighting began in 1992, the country's limited infrastructure has collapsed. Many homes have been intentionally razed, damaged or destroyed by fighting. The internal displacement of large portions of the indigenous population continues to degrade the environment through the indiscriminate disposal of solid and municipal waste. Large numbers of refugees, poor sanitation and water treatment, and disrupted medical support have greatly increased the risk of epidemics. Soils contaminated over decades with hazardous industrial wastes, such as PCBs, pose additional risks to human health.

C. Bulgaria.

1. Geography. Bulgaria is slightly larger than Tennessee and has a land area of about 110,500 sq km. It consists of four geographic regions: (1) The Danubian Plain is a fertile, hilly area following the course of the Danube River. It begins in the north along the border with Romania and covers nearly one-third of the country. (2) The Balkan Mountains, or Stara Planina (Old Mountains), border the southern edge of the Danubian Plain and have a maximum elevation of 2,377 m. The Sredna Gora (hills) parallel the southern edge of the Balkan Mountains. (3) South of the Balkan Mountains and the Sredna Gora is the Thracian Plain that includes the Maritsa River Basin and the lowlands extending inland from the Black Sea. (4) A massif, consisting of the Rila, Rhodope and Pirin Mountains, separates the Thracian Plain from the border with Greece. Elevations

reach a maximum of 2,925 m at Musala in the Pirin Mountains. Bulgaria is bordered on the north by Romania, on the west by Serbia and Montenegro and Macedonia, on the south by Greece and Turkey, and on the east by the Black Sea.

2. Climate. Bulgaria has a complex climate influenced by its mountains and valleys, air masses from the Mediterranean and continental climatic zones, and the Black Sea. In the north, summers (June through August) usually have a mean daily maximum temperature of about 26°C, while winters (December through February) experience mean daily minimum temperatures of about -0.3°C. Precipitation is evenly distributed throughout the year. On the Thracian Plain, summers are long, with high temperatures and humidity. Here precipitation is erratic from year to year, with prolonged and severe droughts during summer. The southern slope of the Rhodope Mountains has mild, damp winters with a mean daily minimum temperature of approximately 0°C and hot, dry summers with a mean daily minimum temperature of 26°C. Annual precipitation averages about 635 mm countrywide. The coastal and plains regions receive less than this average, and the mountains receive more than average. Temperature inversions frequently occur throughout the uplands and the many valley basins. Black winds, named after the large amount of dust carried by the wind, are common in winter along the Danube River Basin. Frequent dust storms can cause breathing difficulties and eye irritation. Risk of cold injury exists at higher elevations in the Rhodope and Pirin Mountains.

Sofia (elevation 5500 m)												
Mean Daily Temperatures (°C)												
MONTH	J	F	M	A	M	J	J	A	S	O	N	D
MAXIMUM (°C)	1	4	9	16	20	24	26	27	23	17	10	4
MINIMUM (°C)	-5	-3	-1	4	9	12	14	14	11	6	2	-2

Monthly Precipitation (liquid equivalent)												
MEAN (mm)	26	28	41	61	87	73	68	64	41	65	48	49

3. Population and Culture. Bulgaria is one of Europe's most sparsely populated countries, with approximately 81 persons per sq km. The highest population density occurs in the Sofia River Basin and the southwestern portion of the Thracian Plain. The least densely populated areas are located at higher elevations, particularly in the Rhodope Mountains. Land use includes: 37% arable, 18% crops or pasture, and 35% forests or woodlands. Bulgaria's ethnic makeup is 85.3% Bulgarians, 8.5% Turks, 2.6% Gypsies,

2.5% Macedonians, and 1.1% Armenians, Russians, or other origins. Its religious makeup includes: 85% Orthodox Christians, 13% Muslims, 0.8% Jews, 0.5% Roman Catholics, and 0.7% others. Total population 8.2 million, 67% urbanized, literacy rate 98%.

4. Water, Living and Sanitary Conditions. Rivers and underground waters are the most important sources of water for industrial, agricultural and domestic uses. The quantity and quality of water in Bulgaria are heavily influenced by the upstream impacts of neighboring countries in the Danube basin (including the Czech Republic, Slovak Republic, Hungary and Romania). Water supplies are problematic throughout the country because of drought and upstream water extraction. Water rationing is common in urban areas during summer. Industry and agriculture have priority for water and use over half of the potable supply. Bulgaria's ground water has a high mineral content. Municipal water treatment systems are ineffective, distribution systems are degraded, and demand for services exceeds the government's ability to meet water needs. From 30 to 50% of treated water is lost during distribution. Few homes in Bulgaria are hooked up to a municipal water supply. The water in the capital city of Sofia is considered bacteriologically safe to drink, but it has a poor taste due to a high mineral content. Water for domestic use in rural areas is frequently untreated and comes directly from raw sources. Consequently, water-borne diseases are common. Pools from leaking water systems attract and support significant populations of vector and pest species. Except in large cities, food processing, refrigeration, and preparation standards are poor. Most older and larger cities in Bulgaria combine wastewater and storm water in the sewer system. Interceptors and pump stations, designed to carry flows from sewer systems, rarely support entire cities. Transmission of food-borne pathogens is common. Effective wastewater treatment plants with secondary treatment designed to remove nutrients causing eutrophication have been built only in a few large cities. None of the plants provides adequate disinfection. Over 60% of the rivers in Bulgaria are adversely affected by partially treated domestic and industrial sewage. Rural areas depend on cesspits and latrines. Large urban areas regularly collect garbage and trash for incineration or disposal in landfills, while rural areas generally use small, unregulated, family dump sites. Soils have been contaminated over decades by industrial wastes and chemicals, and air is polluted by industrial emissions. Nuclear wastes stored at the power plant at Kozloduy and uranium ore tailings at mines in Silen, Karandila and Bukhovo are additional public health threats.

D. Croatia.

1. Geography. Croatia is slightly smaller than West Virginia and has a total land area of 56,400 sq km. It comprises three geographic regions: (1) A long, narrow coastal region extends from the Istrian Peninsula down the Dalmatian coast to Dubrovnik and includes more than 1,000 small Adriatic Sea islands. (2) The Dinaric Alps run northwest to

southeast and parallel the coastline. Several peaks in the Dinaric Alps have elevations greater than 1,600 m. The highest elevation is 1,830 m at Dinara. (3) The Pannonian Plain is an agriculturally rich region of northern Croatia that consists mostly of flat plains, wide valleys, rolling hills and a few low mountains. Croatia is bordered on the north by Hungary and Slovenia, on the west by the Adriatic Sea, on the south by Bosnia and Herzegovina, and on the east by Serbia and Montenegro. Croatia is subject to frequent, destructive earthquakes.

2. Climate. Croatia's climate is warm in summer and cold in winter. In Zagreb, temperatures reach as low as -24°C in January and as high as 37°C in July. Mountain areas have lower winter temperatures and heavy snowfall. Summers tend to be dry and winters mild along the Adriatic coast; however, during the winter, strong, gusty winds known as the bora bring cold air from Central Europe for several days at a time. Annual precipitation averages about 1,900 mm. Autumn and winter precipitation on the coast is heavy, and the Dinaric Alps south of Dubrovnik are among the wettest areas in Europe during winter.

Zagreb (elevation 110 m)												
Mean Daily Temperatures (°C)												
MONTH	J	F	M	A	M	J	J	A	S	O	N	D
MAXIMUM (°C)	3	6	11	17	21	25	28	27	22	16	10	3
MINIMUM (°C)	-2	-1	3	8	12	15	17	16	13	8	5	-1

Monthly Precipitation (liquid equivalent)												
MEAN (mm)	86	104	124	132	201	157	229	201	224	198	183	112

3. Population and Culture. There are more than 490,000 displaced persons throughout Croatia, mostly living in enclaves and refugee centers. Reintegration efforts, continued ethnic tension, and the approaching expiration of the UN mandate have resulted in a very dynamic population situation. This has severely strained the health care system throughout the country. Before the civil war began in 1992, Croatia's ethnic makeup was 78% Croats, 12% Serbs and 10% other origins. The religious makeup was 77% Roman Catholics, 11% Orthodox Christians, and 12% Muslims, Protestant Christians and other religious traditions. Land use includes about 21% arable, 22% crops and pasture, and 38% forests and woodlands. Fishing is a major industry in Croatia. Before the war, the

population was 97% literate. Total population is 4.6. million. The current literacy rate and the percent urbanized are unknown due to the civil war.

4. Water, Living and Sanitary Conditions. Croatia's major water sources include rivers, streams and wells. Water is generally available year-round, although the quantity of surface water varies with season (most available November through June) and region (shortages occur along the Adriatic coast). Water treatment and distribution systems have been disrupted throughout Croatia. Water is either partly treated or not treated at all. Damage to water distribution systems or intermittent pumping that allows back flow contribute to unreliable water quality at the tap. Vertical pipes in the distribution system are subject to breakage from freezing, illegal taps and sabotage. Outbreaks of food and water-borne disease are common. Since the signing of the Dayton Agreement, peacekeeping forces and many nongovernmental organizations have been trying to repair and improve water treatment and distribution systems for the indigenous population. However, the damage in many locations is extensive and will take many years to repair. Since the war began in 1992, the country's infrastructure has collapsed. Waste disposal sites are limited in urban areas. Many homes have been intentionally razed, damaged or destroyed by fighting. Mass movement of refugees has severely degraded sanitary and environmental conditions. The threat of vector-borne disease is high. Numerous farms and food processing facilities have been destroyed, and nutrition is inadequate for much of the population. Soil, water and air in many areas of Croatia are contaminated by industrial emissions and chemicals such as arsenic, trihalomethane, PCBs, sulfates and petrochemicals.

E. Czech Republic.

1. Geography. The landlocked Czech Republic covers an area of 78,800 sq km and is slightly smaller than South Carolina. It is bordered on the north by Poland, on the west by Germany, on the south by Austria, and on the east by the Slovak Republic. The highest elevation is 1,602 m at Snezka; the lowest elevation is 115 m at the Elbe River. The country can be divided into two geographic regions, Bohemia and Moravia. The Bohemian region in the west consists of rolling plains, hills, and plateaus surrounded by low mountains with elevations under 1,600 m. The Plain of Polabi in central Bohemia has fertile soils and extensive coal deposits. Moravia, the lowland region in the east, comprises rugged hills with an average elevation of 150 m, but becomes more rugged and mountainous eastward. The country has numerous rivers and lakes, and many peaks are high enough to be suitable for skiing much of the year.

2. Climate. The Czech Republic has a temperate climate with moderate summers and cold, humid winters. In July, temperatures have reached as high as 38°C, and in February, as low as -24°C. There is little climatic variation in the two regions of the country, except that the basins and lowlands are warmer and drier than mountainous areas. Annual precipitation averages about 411 mm. Frequent morning fogs and dense cloud cover are prevalent in the valleys and lowlands. In winter, the ground may be covered with snow from 40 to 100 days, depending on elevation.

Prague (elevation 260 m)												
Mean Daily Temperatures (°C)												
MONTH	J	F	M	A	M	J	J	A	S	O	N	D
MAXIMUM (°C)	0	1	7	12	18	21	23	22	18	12	5	1
MINIMUM (°C)	-5	-4	-1	3	8	11	13	13	9	5	1	-3
Monthly Precipitation (liquid equivalent)												
MEAN (mm)	18	18	18	27	48	54	68	55	31	33	20	21

3. Population and Culture. The population of the Czech Republic is concentrated in the highly industrialized areas of northern Bohemia, northern and southern Moravia, and in the major cities of Prague, Brno and Ostrava. The country has a skilled industrial work force, but unemployment is rising because of limited foreign investment. Land use includes: 41% arable, 13% crops and pasture, and 34% forests and woodlands. The ethnic makeup includes 94% Czechs, 3% Slovaks, and 3% Poles, Germans, Hungarians and others. Religious makeup includes 40% atheists, 39% Roman Catholics, 5% Protestant Christians, 3% Orthodox Christians, and 13% others. Total population 10.3 million, 70% urbanized, literacy rate 99%.

4. Water, Living and Sanitary Conditions. Both surface water and ground water sources are limited. Rural populations depend primarily on well water. Water purification systems are inadequate in major cities, and the quality of water is declining. The quality of surface water is poor due to ineffective waste treatment. Even after treatment, more than half of drinking water supplies fail to meet Czech standards. Risk of waterborne disease is high. Although living standards fell after the recent political and economic upheaval, they are still above most Central European standards. Less than one-fifth of municipal sewage receives any treatment before release. Many towns have inadequate or no sewage treatment plants. Sewage treatment facilities in large cities, such as Prague, Brno and Plzen, typically exceed their capacity by 40%, and most facilities are antiquated and function poorly. Rural populations typically dispose of sewage in cesspools or privies. Soil, water and air in many areas of the Czech Republic are heavily contaminated by industrial emissions and chemicals such as lead, arsenic, cadmium, nitrates, PCBs, sulfates and petrochemicals. Local produce, such as dairy products, meat, sausage and fish, often contains hazardous levels of one or more of these contaminants. Soviet military occupation forces reportedly left many unexploded shells and land mines in place on or around their former military installations.

F. Greece.

1. Geography. Greece is the third largest and the southernmost country of Central Europe. It is slightly larger than the state of New York and has a land area of 130,800 sq km. It is bordered on the north by Albania, Macedonia, and Bulgaria; on the west by the Adriatic Sea; on the south by the Aegean and Mediterranean Seas; and on the east by Turkey. The geography is mountainous and generally slopes from the northwest toward the southeast. The Pinkos Mountain chain runs from Albania southeastward to the Mediterranean coast. An eastern arm of this mountain chain includes the highest point in Greece, Mt. Olympus, at 2,917 m, which is near the Aegean Sea coast. The higher elevations in the north and northwest sometimes have temperatures low enough to pose a risk of cold injury in persons who are not properly protected. The soil is generally very shallow and rocky, mostly suitable for pasture or olive trees. There are rich mineral deposits in Greece, including rare minerals like chromium. Greece possesses over 2,000 islands and has more than 120 seaports suitable for either passenger or cargo traffic, most notably at Athens and Thessaloniki. The country is subject to severe earthquakes.

2. Climate. Greece generally has a Mediterranean climate, with mild wet winters and hot dry summers. Higher mountain areas can be cold in winter, sometimes reaching -10°C. Snow may fall anywhere in Greece, but it is seldom very heavy and never remains on the ground more than a few hours except at higher elevations. Sea breezes moderate temperature changes at lower elevations.

Athens (elevation 107 m)

Mean Daily Temperatures (°C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
MAXIMUM (°C)	13	14	16	20	25	30	33	33	29	24	19	15
MINIMUM (°C)	6	7	8	11	16	20	23	23	19	15	12	8

Monthly Precipitation (liquid equivalent)

MEAN (mm)	62	37	37	23	23	14	6	7	15	51	56	71
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3. Population and Culture. Historically, Greece was a seafaring and agrarian nation. It has become increasingly urbanized since World War II, and more than half of the population now lives in Athens and Thessaloniki. Currently, the main industries include tourism, shipping, fishing, agriculture, mining and petroleum refining. Land use includes: 49% crops and pasture, 19% arable, and 20% forest or woodlands. The

country's ethnic makeup is 98% Greeks and 2% other origins. Religious makeup includes 98% Orthodox Christians, 1.3% Muslims, and 0.7% other. Unemployment due to a depressed economy has been a problem for several years. Many Albanian refugees have strained the country's infrastructure, especially the economy and health care. Total population 10.6 million, 64% urbanized, literacy rate 94%.

4. Water, Living and Sanitary Conditions. Streams and wells are the main water sources. Rural and mountainous inhabitants frequently depend on catching rainwater in cisterns. Water treatment and distribution are fairly good and reliable, especially in larger towns and cities. Desalinization of sea water is being studied as an alternative source. Local water shortages are often due to earthquakes, which may divert the courses of streams or cause subsurface shifts large enough to stop the flow of even a large aquifer. Sewage is treated and trash is properly disposed of in larger towns, but in some slum areas open dumping is common. In slums, several families may share the same house. This is commonly the case in refugee communities, as well as in some remote agricultural villages. Crowding and poor sanitation in these areas increases the risk of vector-borne disease as well as transmission of food and water-borne pathogens. The civil war in Greece after WWII damaged much of the country's infrastructure. Construction of modern transportation and medical facilities has been slow. In recent years, an influx of Albanian refugees has further strained these facilities. Air pollution and acid rain in Athens have caused serious damage to buildings and ancient monuments.

G. Hungary.

1. Geography. Landlocked Hungary (bordered by Slovakia on the north, Ukraine and Romania on the east, Slovenia, Croatia, and Serbia on the south, and Austria on the west), is slightly smaller than Indiana and has a total land area of about 93,000 sq km. It can be divided into three geographical regions: (1) The Great Hungarian Plain accounts for more than half of the total area and includes the lowlands east of the Danube River. This region has a mean elevation of approximately 90 m. (2) Transdanubia, west of the Danube River, consists primarily of rolling foothills of the Austrian Alps and contains Lake Balaton, Central Europe's largest freshwater lake. (3) The Northern Hill region lies north of Budapest and extends to the Slovak border. Elevation ranges from 78 m on the Tisza River at Hortabagy to Mt. Keles (1,014 m) in the Matra Mountains, northeast of Budapest.

2. Climate. Hungary typically has hot summers from June through August and cold winters from December through February, with little climatic variation throughout the country. Annual extremes range from 35°C in summer to -26°C in winter. Average annual rainfall is 640 mm, but severe droughts may occur in the east during summer. April through August usually is the wettest period, with much of the precipitation in the form of heavy downpours during frequent thunderstorms. Snow generally remains on the ground 30 to 40 days during winter. Winters can be foggy and bitterly cold when easterly winds blow from Russia.

Budapest (elevation 140 m)												
Mean Daily Temperatures (°C)												
MONTH	J	F	M	A	M	J	J	A	S	O	N	D
MAXIMUM (°C)	1	4	10	17	22	26	28	27	23	16	8	4
MINIMUM (°C)	4	-2	2	7	11	15	16	16	12	7	3	-1

Monthly Precipitation (liquid equivalent)												
MEAN (mm)	37	44	38	45	72	69	56	47	33	57	70	46

3. Population and Culture. Except for Budapest, Hungary's population is distributed fairly evenly throughout the country. Average population density is 111 persons per sq km, with more than 20% concentrated in Budapest and its suburbs. Hungary's population has been slowly declining since 1980 when it peaked at 10.7 million. Land use includes: 51% arable, 15% in crops or pasture, and 19% in forests or woodlands. Hungary's ethnic makeup is 90% Hungarians, 4% Gypsies, 3% Germans, 2% Serbs, and the remainder Slovaks or Romanians. Religious makeup includes 68% Roman Catholic, 20% Calvinist, 5% Lutheran, and 7% other. Total population 10.2 million, 63% urbanized, literacy rate 99%.

4. Water, Living and Sanitary Conditions. Water resources throughout the country are unevenly distributed, and approximately 70% of water supplied from surface sources comes from surrounding countries. Water shortages occur during hot, dry summers in some lowland areas. Most groundwater resources consist of bank-filtered waters (aquifers along the Danube and other rivers), in addition to artesian wells and karstic waters. The Danube River and its tributaries typically flood in April, May or June. Ground water levels in the area between the Danube and Tisza rivers were reported in 1996 to be 3 to 5 m below average. The ground water level in the Szigetkoz area, just north of Budapest, has been severely lowered by the diversion of the Danube by the Bos-Nagymaros dam project in Slovakia. The flatness of the land and water level fluctuations make the Carpathian basin susceptible to salinization. About 85% of Hungary's population has piped, treated drinking water. However, the risk of water-borne diseases is high because of antiquated distribution systems. Many smaller settlements throughout the country rely on water from tanker trucks. Municipal sewage systems are outdated and inadequate to meet the needs of the population. Although approximately half of the homes in Hungary are connected to public sewage systems, only half of the sewage is properly treated. In rural communities, many people rely on septic tanks, cesspools, and privies. At least 165 million m³ of untreated wastewater is dumped into Hungarian rivers each year. Another 439 million m³ is only partially treated. Several locations in downtown Budapest dump untreated sewage directly into the Danube. About 33% of

Budapest homes are not connected to the sewer system. The majority of landfills in Hungary do not meet minimal environmental safety standards, and hazardous wastes are mixed with domestic wastes. The number of illegal landfills is increasing. Budapest has a well-organized system of solid waste disposal, but collection and disposal of solid waste in other parts of the country are inadequate. Air, soil and water pollution are serious problems. Soils are severely contaminated at 340 decommissioned former Soviet military bases throughout the country. Fuels, lubricants, solvents, and other unidentified toxic materials have permeated the soil from leaking tanks or open ponds and pits. Crops harvested from these soils are often contaminated by industrial wastes and chemicals.

H. Macedonia.

1. Geography. Macedonia is landlocked and has a land area of 24,900 sq km. The country is slightly larger than Vermont. It is bordered on the north by Serbia and Montenegro, on the west by Albania, on the south by Greece, and on the east by Bulgaria. Macedonia is characterized by high mountain ranges, with several peaks exceeding 2,450 m elevation. The highest elevation is 2,753 m at Korab, near the northwestern border with Albania. The lowest elevation is 50 m where the Vardar River flows into Greece. The country has two large lakes, Ohrid and Prespa, both in the southwest on the Albanian border. Macedonia is highly prone to earthquakes.

2. Climate. Macedonia's climate is characterized by hot summers and autumns, and cold winters with heavy snowfall lasting several months. Average temperatures are as high as 41°C in July and August, and as low as -21°C in January and February. Winters tend to be mild in the Varder Valley, which runs northwest to southeast through the center of the country. Annual precipitation averages about 500 mm, with dry autumns and wet springs.

Skopje (elevation 230 m)												
Mean Daily Temperatures (°C)												
MONTH	J	F	M	A	M	J	J	A	S	O	N	D
MAXIMUM (°C)	5	8	12	19	23	28	30	30	26	19	12	7
MINIMUM (°C)	-3	-3	1	5	10	13	15	14	11	6	3	-1

Monthly Precipitation (liquid equivalent)

MEAN (mm)	39	32	37	38	54	47	29	28	35	61	55	53
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3. Population and Culture. Macedonia, the poorest republic in the former Yugoslavia, is ethnically diverse and urbanized. About 40% of average household income is used to buy food. Population density averages 79 inhabitants per sq km. Land use includes: 24% arable, 27% crops and pasture, and 39% forests and woodlands. The main industries are mining, agriculture and tourism. Macedonia's ethnic makeup is 65% Macedonians, 22% Albanians, 4% Turks, 2% Serbs, and 7% Gypsies and other origins. The country's religious makeup is 67% Orthodox Christians, 30% Muslims, and 3% other. Tensions between different ethnic groups in Macedonia are far more restrained than in other countries that were once part of Yugoslavia. Large refugee populations immigrated to Macedonia during regional civil wars. Total population 2.1 million, 58% urbanized, literacy rate 89%.

4. Water, Living and Sanitary Conditions. Macedonia's water sources include rivers, streams and wells. Seasonal and regional shortages occur. Although some urban areas have access to adequate water treatment and distribution systems, water quality is unreliable in most areas of the country. Many urban homes are not connected to municipal water systems, and rural communities rely on private wells, cisterns and public standpipes for water. Water supplies are frequently contaminated by fecal wastes and agricultural runoff. Macedonia has few urban sewage treatment systems, and waste collection and disposal are generally inadequate. Rural areas rely on outdoor pit latrines and privies to dispose of wastes. Adequate food processing and preparation measures are poor except in large urban areas. Food-borne diseases are common. Many rural homes lack electricity and fuel for heating and cooking. Packed-dirt floors are common in the homes of poorer communities. Livestock are frequently housed near human living quarters, and in winter livestock may be moved into homes. Although Macedonia does not have the concentration of heavy industry seen in some parts of Central Europe, there is serious localized air pollution from electrical power plants and factories that use coal. The most severely polluted area is Skopje, the site of most Macedonian industry.

I. Poland.

1. Geography. Poland, with a land area of about 304,500 sq km, is slightly smaller than New Mexico and can be divided into four geographic regions: (1) In the far north, the Baltic coastal plain consists of swamps and dunes that stretch across northern Poland

from Germany to Russia. Poland's Baltic coastline is about 700 km long. The lowest elevation in Central Europe lies within a geological depression at Raczki Elblaskie. (2) A belt of thousands of lakes mixed with hills constitutes the region south of the coastal plain. (3) A great central lowlands area, most of which lies below 300 m, covers about 75% of the country. (4) In the south, the lowlands give way to the Little Poland Uplands that vary in elevation from 200 to 500 m. The Sudeten and Carpathian Mountains reach a peak elevation of 2,500 m and form a natural border with the former Czechoslovakia. The highest point in Poland is a peak of 2,499 m in the Tatra Mountains at Rysy, just inside the border with the Slovak Republic. Poland is bordered on the north by the Baltic Sea, Russia and Lithuania, on the west by Germany, on the south by the Czech Republic and Slovak Republic, and on the east by Belarus and the Ukraine.

2. Climate. Poland's climate is characterized by hot summers (June through August) and cold winters (November through March), with more temperate conditions in the west than in the east. The worst winter weather is caused by strong easterly winds that produce severe winter cold. Poland's mean annual precipitation is low, ranging from 500 to 625 mm. The mountains receive about twice the amount of precipitation that falls on the central Polish lowlands. Snow covers the ground for an average of 40 days during winter in the north and west, and for as much as 70 days in the south and east. Floods frequently occur in low-lying areas during the spring thaw and after summer thunderstorms. Flooded areas can produce tremendous populations of mosquitoes and other blood-sucking insects.

Warsaw (elevation 110 m)												
Mean Daily Temperatures (°C)												
MONTH	J	F	M	A	M	J	J	A	S	O	N	D
MAXIMUM (°C)	0	0	6	12	20	23	24	23	19	13	6	2
MINIMUM (°C)	-6	-6	-2	3	9	12	15	14	10	5	1	-3

Monthly Precipitation (liquid equivalent)												
MEAN (mm)	27	32	27	37	46	69	96	65	43	38	31	44

3. Population and Culture. Average population density is 123 persons per sq km, but most Poles live in major cities located in the central plains. Major urban areas include Warsaw, Lodz, Wroclaw, Krakow, Katowice and the Baltic port cities of Gdansk and Gdynia. Land use includes: 47% arable, 14% crops and pasture, and 29% forests or woodlands. There are very few ethnic minorities in Poland. Poland's ethnic makeup is about 97.6% Polish, 1.3% German, and 1.1% others. The country's religious makeup is

95% Roman Catholic and 5% other, including Orthodox and Protestant Christians. Main industries are mineral production, coal, petroleum refining and agriculture. Poland is located within natural land transportation routes through Europe, and the port cities of Gdansk and Gdynia are excellent harbors on the Baltic Sea. Total population 38.6 million, 68% urbanized, literacy rate 99%.

4. Water, Living and Sanitary Conditions. Poland has abundant surface water resources, but extensive pollution reduces their utilization and has increased the demand for ground water, which is becoming depleted. Water treatment and distribution systems are unreliable, aging and poorly maintained even in major cities. More than one-third of the treated water is lost because of leaks in the distribution system. About 10% of the urban population and more than half of village populations lack access to water distribution systems. More than half of rural inhabitants use wells for their water supply. Living conditions in Poland have deteriorated since the breakup of the Soviet Union and subsequent social changes in eastern Europe. One-third of Poland's towns do not have sewage-treatment plants, and those systems operating in Poland's major cities generally are poorly constructed, aging and inadequate to meet existing needs. Less than 40% of the country's sewage receives treatment before being discharged into waterways. Villages and small towns rely on septic tanks and privies. Household and industrial wastes often end up in the same disposal site. Utilities in Poland are subject to unscheduled outages lasting for hours or days. Serious housing shortages exist in urban areas, forcing many families to live in small apartments. Housing is characterized by poor maintenance and low-quality construction. Decades of poorly regulated heavy industry have resulted in significant pollution of soil, water and air in many areas of Poland. In the past, Poland accepted shipments of toxic and hazardous waste in return for hard currency but lacked facilities for safe disposal. Poland generates about 100 m³ of radioactive waste annually, primarily from hospital and academic sources. Radioactive waste is stored in Poland's only waste site at Rozane, in Ostroleka Province. Traces of residual cesium (Cs-137) contamination from the nuclear accident at Chernobyl are reported in southwestern Poland, in the eastern Sudety Mountains, the Tectonic Foreland and the Silesian Plain. A contaminated zone stretches from the Polish-Czech border in the Klodzko Valley to Warsaw. Cs-137 contamination has appeared in some agricultural products.

J. Romania.

1. Geography. Romania is slightly smaller than Oregon and has a total land area of 230,300 sq km. It can be divided into four geographic areas: (1) Central Romania is dominated by the Carpathian Mountains and the Transylvanian Alps that reach a peak elevation of 2,544 m at Mt. Moldoveanu. (2) Transylvania is a hilly plateau region in the northwest. (3) The Romanian Plain and the regions of Wallachia and Moldavia consist of lowlands and fertile plains in the south and east. (4) The coastal plains of the Black Sea

and the Danube Delta lie in the country's easternmost region. Romania is bordered on the north by the Ukraine, on the west by Hungary and Serbia and Montenegro, on the south by Bulgaria, and on the east by Moldova, the Ukraine and the Black Sea. Romania is prone to earthquakes and landslides, which are most severe in the south and southwest. Flooding is common and often severe, particularly during spring thaw and summer thunderstorms.

2. Climate. Romania normally has warm, sunny summers from June through August and cold, snowy winters from November through March. Daily highs of 38°C sometimes occur in the lowlands during July and August. Temperatures as low as -30°C have been recorded throughout much of Romania during the winter. The climate along the Black Sea is mild. Average annual precipitation is about 710 mm, except at higher elevations where precipitation may exceed 1,270 mm annually. Frequent thunderstorms occur during the wettest months of April through July. In winter, snow remains on the ground 30 to 50 days a year in the lowlands and up to 100 days a year in the mountains. Winds blowing across the plains from the Russian steppes can cause severe droughts during dry summers and bitter cold during winters. Cold injury is a serious health threat.

Bucharest (elevation 90 m)

Mean Daily Temperatures (°C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
MAXIMUM (°C)	1	4	10	18	23	27	30	30	25	18	10	4
MINIMUM (°C)	-7	-5	-1	5	10	14	16	15	11	6	2	-3

Monthly Precipitation (liquid equivalent)

MEAN (mm)	46	26	28	59	77	121	53	45	45	29	36	27
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3. Population and Culture. Romania's predominantly rural population is rapidly urbanizing. The current population density is 96 persons per sq km. Most people live in the plains in the south and east. The Danube Delta and Black Sea coastal plains are sparsely populated. Romania's ethnic makeup is 89% Romanians, 9% Hungarians, and 2% others. The country's religious makeup is 70% Orthodox Christians, 6% Roman Catholics, 6% Protestant Christians, and 18% others. Land use includes: 41% arable, 24% permanent crops and pasture, and 29% forests or woodlands. Total population 22.4 million, 55% urbanized, literacy rate 97%.

4. Water, Living and Sanitary Conditions. Romania's water is obtained from lakes, rivers, reservoirs and groundwater sources. There are seasonal and regional water

shortages, primarily in the Black Sea coastal region and delta areas of the Prut and Danube Rivers. Even when treated, water may be contaminated due to antiquated or ineffective treatment and distribution systems. About 80% of the urban and 15% of the rural population have access to piped water in their homes. Increasing urbanization is straining the water treatment and distribution infrastructure. Interruptions in water supply occur due to breakdowns in pressure pumps or malfunctions in the distribution system and can result in contamination due to back siphoning. Water-borne diseases are common. During periods of drought, urban areas without adequate reserves must ration limited water supplies. Crowded living conditions prevail in urban areas, including Bucharest, and interruptions in electrical and water services are common. Sanitation is poor, and abandoned buildings are frequently used as dump sites. Less than 60% of the urban population is connected to sewer systems. The larger cities in Romania have designed sewer systems to handle both wastewater and storm water runoff. Interceptors and pump stations are not effective in channeling the flow of sewer systems, and they rarely support entire cities. Effective wastewater treatment plants have been built in only a few of the large cities, and none of the plants provide adequate disinfection capabilities. Most rivers in Romania are polluted by domestic sewage and agricultural runoff. Households not connected to a sewer network rely on septic tanks or latrines. Soil and air pollution are serious public health threats. Radiation hazards exist at the Cernavoda nuclear power plant and in the town of Mioveni, Arges County, where nuclear fuel is manufactured.

K. Serbia and Montenegro.

1. Geography. Serbia and Montenegro is slightly larger than Kentucky and has a total land area of 102,200 sq km. It can be divided into three geographic areas: (1) Northern Serbia is dominated by the Pannonian Plain, an agriculturally rich area of flat plains and low, rolling hills. (2) The Black, Sar, and Balkan Mountains contain several peaks exceeding 2,450 m elevation and dominate southern Serbia. The highest elevation in the country is 2,656 m at Deravica, near the Albanian border. Wide river valleys and rolling hills also are scattered throughout the region. (3) In the southwest, Serbia and Montenegro has a 200-km long mountainous coastline on the Adriatic Sea. Serbia and Montenegro is bordered on the north by Hungary and Romania, on the west by Bosnia and Herzegovina, Croatia, and the Adriatic Sea, on the south by Albania and Macedonia, and on the east by Bulgaria. The region is subject to destructive earthquakes.

2. Climate. The climate is characterized by cold winters and hot, humid summers. Temperatures in Belgrade are as low as -25°C in January and as high as 39°C in July and August. Snow accumulations at higher elevations last throughout the winter. The coastal area has dry summers and mild, wet winters. The heaviest precipitation occurs along the coast. Mean annual precipitation is 1,550 mm in Podgorica and 700 mm in Belgrade.

Belgrade (elevation 100 m)												
Mean Daily Temperatures (°C)												
MONTH	J	F	M	A	M	J	J	A	S	O	N	D
MAXIMUM (°C)	3	5	11	18	23	26	28	28	24	18	11	5
MINIMUM (°C)	-3	-2	2	7	12	15	17	17	13	8	4	0

Monthly Precipitation (liquid equivalent)												
MEAN (mm)	J	F	M	A	M	J	J	A	S	O	N	D
	47	46	46	54	74	96	61	55	50	55	61	55

3. Population and Culture. Average population density is 102 persons per sq km. The highest density (179 per sq km) is in the southern province of Kosovo and the lowest (45 per sq km) is in Montenegro. Almost 10% of the population lives in and around Belgrade. Ethnic hatred has resulted in bitter conflict between Albanians and Serbs. As a result of civil war in the former Yugoslavia, more than 600,000 refugees have fled to Serbia and Montenegro. The ethnic makeup of Serbia before the war was 63% Serbs, 14% Albanians, 6% Montenegrans, 4% Hungarians, and 13% from other origins. The religious makeup was 65% Orthodox Christian, 19% Muslims, 4% Roman Catholics, 1% Protestants, and 11% other. Demographic estimates before the civil war: total population 11.2 million, 47% urbanized, literacy rate 93%.

4. Water, Living and Sanitary Conditions. Water sources include the Sava and Danube rivers in addition to streams and wells. Seasonal and regional water shortages occur, particularly in Kosovo and in Montenegro's coastal area. Water treatment and distribution systems are unreliable; water is either partly treated or not treated at all. Water treatment and distribution systems in the Vojvodina region are extremely degraded. Cities where municipal water treatment systems still operate include Subotica, Sombor, Gornji, Milanovac and Kragujevac. Although most major cities have piped water, nearly half of all dwellings nationwide are not connected to a central, piped water system. The country's infrastructure has been severely degraded by civil war. Overcrowding and the mass movement of refugees have severely degraded sanitary and environmental conditions and have disrupted agricultural production. Risk of vector-borne diseases is high. Serious air, water, and soil pollution threaten public health.

L. Slovak Republic.

1. Geography. Landlocked Slovakia (bordering countries include Austria, the Czech Republic, Poland, Ukraine, and Hungary) covers an area of 49,000 sq km and is about twice the size of New Hampshire. The country can be divided into two geographic regions: (1) The Carpathian Mountains, which dominate northern and central Slovakia, run in an east-west direction and reach their highest elevation of 2,655 m at Gerlachovka. (2) In the southern region, the Slovak lowlands extend from the foothills of the Carpathian Mountains to the Danube River.

2. Climate. Except for elevation, climatic conditions vary little throughout Slovakia. The months of December through February are cold, cloudy, and humid, with fog in low-lying areas. In February, daily temperatures have dropped to as low as -24°C. Mountains are usually snow covered from November through April, while lower elevations rarely have more than 150 mm of snow cover at a time. Summer is warm and wet. Extreme heat is rare, although temperatures occasionally reach 38°C. Temperatures in mountainous areas are as much as 10°C lower than in Bratislava.

Bratislava (elevation 130 m)												
Mean Daily Temperatures (°C)												
MONTH	J	F	M	A	M	J	J	A	S	O	N	D
MAXIMUM (°C)	1	3	9	16	21	24	27	26	22	15	8	3
MINIMUM (°C)	-5	-3	1	5	9	13	14	14	9	5	1	-3

Monthly Precipitation (liquid equivalent)												
MEAN (mm)	46	39	40	53	65	51	70	64	50	54	69	56

3. Population and Culture. Slovakia's population is concentrated primarily in the urban and highly industrialized areas of Bratislava, Kosice and Nitra. Most of the Carpathian Mountain region and portions of the Danube Basin region are sparsely populated. Land use includes: 31% arable, 20% crops and pasture, and 41% woodlands. The ethnic makeup is 86% Slovaks, 11% Hungarians, 1% Gypsies, and 2% other. The country's religious makeup is 60% Roman Catholic, 10% atheist, 8% Protestant, 4% Orthodox Christian, and 18% other. Total population 5.4 million, 57% urbanized, literacy rate 99%.

4. Water, Living and Sanitary Conditions. Most drinking water comes from surface supplies. Erosion and flooding have resulted from unsound agricultural practices and deforestation. Rural inhabitants are dependent on well water, and many areas in Slovakia

experience shortages of drinking water. Even in major cities, water purification systems are considered inadequate. Attempts to improve the quality of surface water sources fail because of ineffective waste treatment. Sanitary conditions are below Western standards. Only 353 of 2,825 communities are linked to public sewers, and sewage treatment plants have been built in only 225 towns and villages. The rural population disposes of sewage in cesspools or privies. Consequently, the risk of food and water-borne disease is high. Ground and surface water is contaminated from uncontrolled industrial and municipal discharges, agricultural runoff, and inadequate storage of hazardous wastes. Acid rain is a severe problem in this country.

M. Slovenia.

1. Geography. Slovenia is slightly larger than New Jersey and has a land area of 20,300 sq km. There are three distinct geographical regions: (1) The Julian Alps in the north are among the most rugged in Europe and contain Mt. Triglav, the highest peak in the country with an elevation of 2,864 m. (2) In eastern Slovenia, the mountains are less rugged and decrease in elevation to about 1,000 m near Maribor. This region contains many valleys and rivers. (3) In the southeast, Slovenia has a 40-km long coastline on the Adriatic Sea. Slovenia is bordered on the north by Austria, on the west by Italy and the Adriatic Sea, on the south by Croatia, and on the east by Hungary. Flooding and earthquakes are common.

2. Climate. Slovenia's climate is generally hot in summer and cold in winter. Temperatures as high as 39°C in July and as low as -28°C in February have been recorded in Ljubljana. The coastal region typically has dry summers and mild winters. Average annual rainfall varies from 800 mm in the east to 3,000 mm in the northwest.

Ljubljana (elevation 360 m)												
Mean Daily Temperatures (°C)												
MONTH	J	F	M	A	M	J	J	A	S	O	N	D
MAXIMUM (°C)	2	5	10	15	20	24	27	26	22	15	8	4
MINIMUM (°C)	-4	-4	0	4	9	12	14	14	11	6	2	-1

Monthly Precipitation (liquid equivalent)												
MEAN (mm)	88	89	76	98	121	133	113	127	142	151	131	114

3. Population and Culture. Slovenia's population is dispersed in small towns. Only two cities have populations greater than 100,000. Average population density is 97 inhabitants per sq km. Slovenia's ethnically homogeneous population has not been involved in the bitter ethnic conflicts seen in the neighboring republics of the former Yugoslavia. The ethnic makeup is 91% Slovenes, 3% Croats, 2% Serbs, and 4% other. The religious makeup is 71% Roman Catholic, 1% Lutheran, 1% Muslim, 4% atheist, and 23% others. Land use includes: 12% arable, 31% crops and pasture, and 51% forests and woodland. Total population 2.0 million, 50% urbanized, literacy rate 99%.

4. Water, Living and Sanitary Conditions. Ground water and springs are the major sources of water in Slovenia. Water is perennially available throughout much of the country; however, shortages occur along the Adriatic coast. The quality of treated water varies widely throughout Slovenia. Municipal water systems may include tertiary treatment, but inadequate water treatment is common. Historically, Slovenia has been one of the most prosperous regions of the Balkans. Infrastructure is well developed, and sanitation in major cities is good. Garbage is collected regularly. There are housing shortages in some urban areas. The influx of refugees, mostly from Bosnia and Herzegovina, has strained Slovenia's limited resources. Overcrowding and poor sanitation are common among displaced persons, and the risk of vector-borne diseases is high in refugee populations. Industrial pollution is not as bad in Slovenia as in most other Central European countries, though the Sava, Slovenia's largest river, is contaminated with industrial wastes, including phenols, petroleum, and heavy metals from the Kranj industrial basin. Agricultural chemicals contaminate surface and ground water sources, particularly in the Celjsko Polje. Localized air pollution is a public health problem in urban areas where soft coal and charcoal are used for heating.

V. Militarily Important Vector-borne Diseases with Short Incubation Periods (<15 days)

A. Sand Fly Fever. (Papatasi fever, Three-day fever)

The sand fly fever group of viruses (*Phlebovirus*, Bunyaviridae) contains at least seven immunologically related types. Naples, Sicilian and Toscana are normally associated with sand fly fever. The virus produces an acute febrile illness lasting 2 to 4 days and is commonly accompanied by headache and muscle pain. There is usually no mortality nor are significant complications associated with infections of Naples or Sicilian viruses, although weakness and depression may persist a week or more after acute illness. However, Toscana virus may cause central nervous system disease in addition to fever. Most infections are acquired during childhood in endemic areas. The clinical disease in children is generally mild and results in lifelong immunity to homologous strains.

Military Impact and Historical Perspective. Sand fly fever has been an important cause of febrile disease during military operations since at least the Napoleonic Wars. In 1909, an Austrian military commission first reported that an infectious agent found in the blood of infected soldiers caused this fever, and that the vector was the sand fly. During World War II, sand fly fever attained importance in Allied and Axis forces in the Mediterranean theater by incapacitating large numbers of men for periods of seven to 14 days. The disease was first recognized in US forces in North Africa in April 1943. Although several thousand cases were reported from 1943 to 1945 in the Mediterranean Theater, the incidence of sand fly fever was undoubtedly underestimated. Many thousands of cases of sand fly fever were probably recorded as fevers of unknown origin, since most medical officers were unfamiliar with the disease and specific tests for diagnosis were not available. In sharp contrast to World War II, there were no reports of sand fly fever among coalition forces during the Persian Gulf War. The military significance of sand fly fever is magnified because of its short incubation period, which may result in large numbers of nonimmune troops being rendered ineffective early in an operation, while endemic forces would be largely immune and unaffected.

Disease Distribution. Sand fly fever is moderately endemic along the Adriatic coast of Albania, Bosnia and Herzegovina, Montenegro, Slovenia, Croatia and its offshore islands as well as landlocked Serbia. In the late 1980s, over 50% of the residents of the Adriatic island of Mljet had antibodies to the Naples virus. Similar high seroprevalences were found on the islands of Brac and Hvar. Sand fly fever is also focally distributed throughout Greece below 2,000 m. The incidence of sand fly fever declined in Greece when residual insecticide spraying for malaria control was initiated in the 1960s but increased again after spraying stopped. Consequently, seroprevalence to Phleboviruses is higher in older age groups. Both Naples and Sicilian viruses circulate in endemic areas, but the Naples virus predominates. Corfu, a *Phlebovirus* closely related to the Sicilian virus, has been isolated from Greece. In temperate regions, the immature stages of sand

flies enter diapause during the winter and adult activity practically ceases. Thus, in most areas of Central Europe, transmission of sand fly fever occurs primarily from May through October, when sand flies are most active. See Figure 1 for the distribution of sand fly fever in Central Europe.

Transmission Cycle(s). No vertebrate reservoir has been clearly established, but small rodents may serve as reservoirs. Infected humans can infect sand flies and thus have an amplifying effect during epidemics. Humans with high levels of virus in the blood more easily infect sand flies. The principal reservoir mechanism appears to be transovarial transmission. The virus is most efficiently replicated in the sand fly vector and transmitted when temperatures exceed 25°C. Infected sand flies remain infective for life and are not harmed by the virus.

Vector Ecology Profiles.

Phlebotomus papatasi is the primary vector throughout the region. *Phlebotomus perfiliewi*, *P. sergenti* and *P. major* are potential vectors. *Phlebotomus papatasi* is widely distributed and has been reported from Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Hungary, Macedonia, Romania, Serbia, and Slovenia. It tends to be more rural and periurban in distribution because it utilizes warm, humid microhabitats, usually animal burrows, for larval development.

Phlebotomus sergenti is also present but is not as ubiquitous as *P. papatasi*. *Phlebotomus sergenti* is distributed in virtually the same countries as *P. papatasi*, except for Hungary, where its presence is uncertain. In some areas, such as Serbia, *P. perfiliewi* is the most abundant species. *Phlebotomus major* is also widely distributed in the region, with a range similar to that of *P. papatasi*. A list of sand fly species and their distribution in Central Europe is shown in Appendix A.2.

Some *P. papatasi* are autogenous; that is, they are capable of producing small numbers of eggs without a bloodmeal, at least during the first gonotrophic cycle. After a bloodmeal, females deposit eggs, 30 to 70 at a time, in rodent burrows, poultry houses, masonry cracks, rock crevices, leaf litter, or moist tree holes. Eggs hatch in one to two weeks, and larvae develop in warm, moist microhabitats that provide abundant organic matter for food. In military fortifications, larvae may live in the cracks between stacked sandbags. There are four larval instars, and four to eight weeks are required to reach the pupal stage. Fourth instar larvae may diapause for weeks or months if environmental conditions are excessively cold or dry. Alternatively, if environmental conditions improve, diapause may be quickly broken. Pupation occurs in the larval habitat. There is no cocoon; rather, the pupa is loosely attached to the substrate by the cast skin of the 4th larval instar.

Phlebotomus papatasi feeds most intensely at dusk and dawn, with some feeding continuing sporadically through the rest of the night. *Phlebotomus papatasi* and

FIGURE 1. ENDEMIC AREAS OF SAND FLY FEVER IN CENTRAL EUROPE (DARK SHADING)



P. sergenti are endophilic and follow odor plumes to their hosts. Only females suck blood, but both sexes feed on plant sugars and nectar. Besides humans, female sand flies feed on the blood of a variety of birds and mammals, commonly dogs, mice, voles and hedgehogs. On humans, they feed on exposed skin around the head, neck, legs, and arms. Female sand flies will crawl under the edges of clothing to bite skin where repellent hasn't been applied. Sand flies feed outdoors or indoors and readily penetrate ordinary household screening. After engorgement, *P. papatasi* and other sand flies rest briefly on objects near their host, then move to gerbil burrows or other cool, moist environments to lay eggs. They also rest in caves and other areas that are relatively cool and shaded during the daytime.

Sand flies are weak fliers and do not travel in wind that exceeds a few kilometers per hour. *Phlebotomus papatasi* may be active at low relative humidities of 45 to 60%, but other vector species require 75 to 80% relative humidity in order to fly and feed. Sand flies fly in short hops, which usually limits their feeding radius to about 100 to 200 m from pupation sites. However, unengorged females may occasionally disperse as far as 1.5 km. Mating dances occur on the ground, often at dusk, with males landing first, followed by females.

Phlebotomus perfiliewi has a life history that is similar to that of *P. papatasi*. However, it is more exophilic than *P. papatasi*, often living in animal shelters and other outdoor manmade structures. Cow manure is one of its most common larval habitats. It was the most common species found in abandoned basements and outdoor latrines in southeastern Serbia. Several isolates of sand fly fever virus were obtained from this species in southeastern Serbia. *Phlebotomus major* is also similar to *P. papatasi* in its life cycle. However, it is more often found outdoors, particularly in animal shelters, and is not as attracted to artificial lights as the other species. It commonly feeds on humans. At least one *Phlebovirus* isolate has been reported from this species in Greece.

Vector Surveillance and Suppression. Because sand flies are small and retiring, specialized methods are required to collect them. The simplest method is active searching of daytime resting sites with an aspirator and flashlight, but this method is very labor intensive. Human-landing collections are an important method of determining which species are anthropophilic. Sticky traps (paper coated with a sticky substance or impregnated with an oil such as castor oil, mineral oil or olive oil) are used to randomly capture sand flies moving to or from resting places. Traps can also be placed at the entrances of animal burrows, caves and crevices, in building debris, and in local vegetation where sand flies are likely to rest during daytime hours. A variety of light traps have been used to collect phlebotomines, but their effectiveness varies according to the species being studied and the habitat. Light traps are inefficient in open desert. Light traps used for mosquito collection should be modified with fine mesh netting in order to collect sand flies. Traps using animals as bait have been also devised. Collection of

larvae is extremely labor intensive and usually unsuccessful because specific breeding sites are unknown or hard to find and because females deposit eggs singly over a wide area. Emergence traps are useful for locating breeding sites. Identification of sand flies requires a microscope and some training; however, with a little experience, sorting and identification by color and size will suffice using minimal magnification. For accurate species identification, laboratory microscopes having 100x magnification are required.

Because of their flight and resting behavior, sand flies that feed indoors are very susceptible to control by residual insecticides. When sand flies are exophilic or bite away from human habitations, control with insecticides is impractical, although the application of residual insecticides to a distance of 100 m around encampment sites may be helpful. Some success in reducing vector populations has been achieved by controlling the rodent reservoir or host population. Selection of encampment sites without vegetation or rock outcroppings that harbor rodents is important. Cleanup and removal of garbage and debris that encourage rodent infestation are necessary for longer periods of occupation. Pets must be strictly prohibited, because any small desert rodent and/or local dog may be infected with leishmaniasis or other infectious diseases.

Sand flies are able to penetrate standard mesh screening used on houses and standard mesh bednets (seven threads per cm or 49 threads per sq cm). These items should be treated with permethrin to prevent entry. Fine mesh (14 threads per cm or 196 threads per sq cm) bednets must be used, but these are uncomfortable under hot, humid conditions because they restrict air circulation. The use of repellents on exposed skin and clothing is the most effective means of individual protection. Insect repellent should be applied to exposed skin and to skin at least two inches under the edges of the BDU to prevent sand flies from crawling under the fabric and biting. The use of **personal protective measures** (see TIM 36) is the best means of preventing sand fly-borne disease.

B. Malaria.

Human malaria is caused by any of four protozoan species in the genus *Plasmodium* that are transmitted by the bite of an infective female *Anopheles* mosquito. Clinical symptoms of malaria vary with the species. The most serious malaria infection, *falciparum* malaria, can produce life-threatening complications, including renal and hepatic failure, cerebral involvement, and coma. Case fatality rates among children and nonimmune adults exceed 10% when not treated. The other human malarial species, *vivax*, *malariae* and *ovale*, are not life-threatening except in the very young, the very old, or persons in poor health. Illness is characterized by malaise, fever, shaking chills, headache, and nausea. The periodicity of the fever, occurring daily, every other day, or every third day, is characteristic of the species. Nonfatal cases of malaria are extremely debilitating. Relapses of improperly treated malaria can occur years after the initial infection in all but *falciparum* malaria. *Plasmodium malariae* infections may persist for

as long as 50 years, with recurrent febrile episodes. Persons who are partially immune or have been taking prophylactic drugs may show an atypical clinical picture. Treatment of malaria has been complicated by the spread of multiple drug-resistant strains of *P. falciparum* in many parts of the world. Current information on foci of drug resistance is published annually by the World Health Organization (WHO) and can also be obtained from the Malaria Section of the Centers for Disease Control and Prevention, and the Armed Forces Medical Intelligence Center.

Military Impact and Historical Perspective. Malaria has had an epic impact on civilizations and military operations. During World War I, in the Macedonian campaign, the French army was crippled with 96,000 cases of malaria. In 1918, over two million man-days were lost in the British Macedonian Army because of malaria. During World War II, malaria caused five times as many US casualties in the South Pacific as did enemy action. In 1942, malaria was the major cause of casualties in General Stilwell's forces in North Burma. There were approximately 81,000 confirmed cases of malaria in the US Army in the Mediterranean Theater from 1942 to 1945. The average length of hospitalization for malaria in 1943 was 17 days, representing a total of 425,000 man-days lost during the year or the equivalent of an entire division lost for a month. In North Africa, the most highly malarious areas during World War II were in Rabat and Port Lyautey in Morocco, the Constantine coast area in Algeria, and the Tunis-Bizerte-Ferryville area in Tunisia. In 1952, during the Korean War, the 1st Marine Division suffered up to 40 cases per 1,000 marines. Battle casualties accounted for only 17% of American hospitalizations during the Vietnam War. Many regiments were rendered ineffective due to the incidence of malaria, and many US military units experienced up to 100 cases of malaria per 1,000 personnel per year. Elements of the 73rd Airborne Brigade had an incidence of 400 cases of malaria per 1,000 during 1967 and early 1968. Almost 300 military personnel contracted malaria during Operation Restore Hope in Somalia. Malaria remains a threat to military forces due to widespread drug resistance in plasmodia, insecticide resistance in the vectors, and the consequent resurgence of malaria in many areas of the world.

Disease Distribution. Endemic malaria has been eradicated from most temperate countries, but it still is a major health problem in many tropical and subtropical areas. Worldwide, there are an estimated 250 to 300 million cases of malaria annually, with two to three million deaths. The WHO estimates that in Africa nearly one million children under the age of 10 die from malaria every year. Globally, *P. falciparum* and *P. vivax* cause the vast majority of cases. *Plasmodium falciparum* occurs in most endemic areas of the world and is the predominant species in Africa. *Plasmodium vivax* is also common in most endemic areas except Africa. *Plasmodium ovale* occurs mainly in Africa, and *P. malariae* occurs at low levels in many parts of the world. In most endemic areas the greatest malaria risk is in rural locations, with little or no risk in cities.

However, in Somalia during Operation Restore Hope (1993), several malaria cases occurred in troops who were only in Mogadishu.

There is no risk of malaria in Central Europe. By the 1970s, malaria had been eradicated from all countries in the region except Greece, which was declared malaria-free in 1986. However, indigenous transmission of malaria in Greece may have occurred as late as 1991. The risk of transmission is greatest along the Turkish border, where *Plasmodium vivax* is highly endemic. Malaria in Central Europe is limited to sporadic imported cases; however, several species of competent vectors exist throughout Central Europe, and *Anopheles* surveillance and control programs have been discontinued in most countries. Conditions for the reestablishment of malaria in the region are favorable.

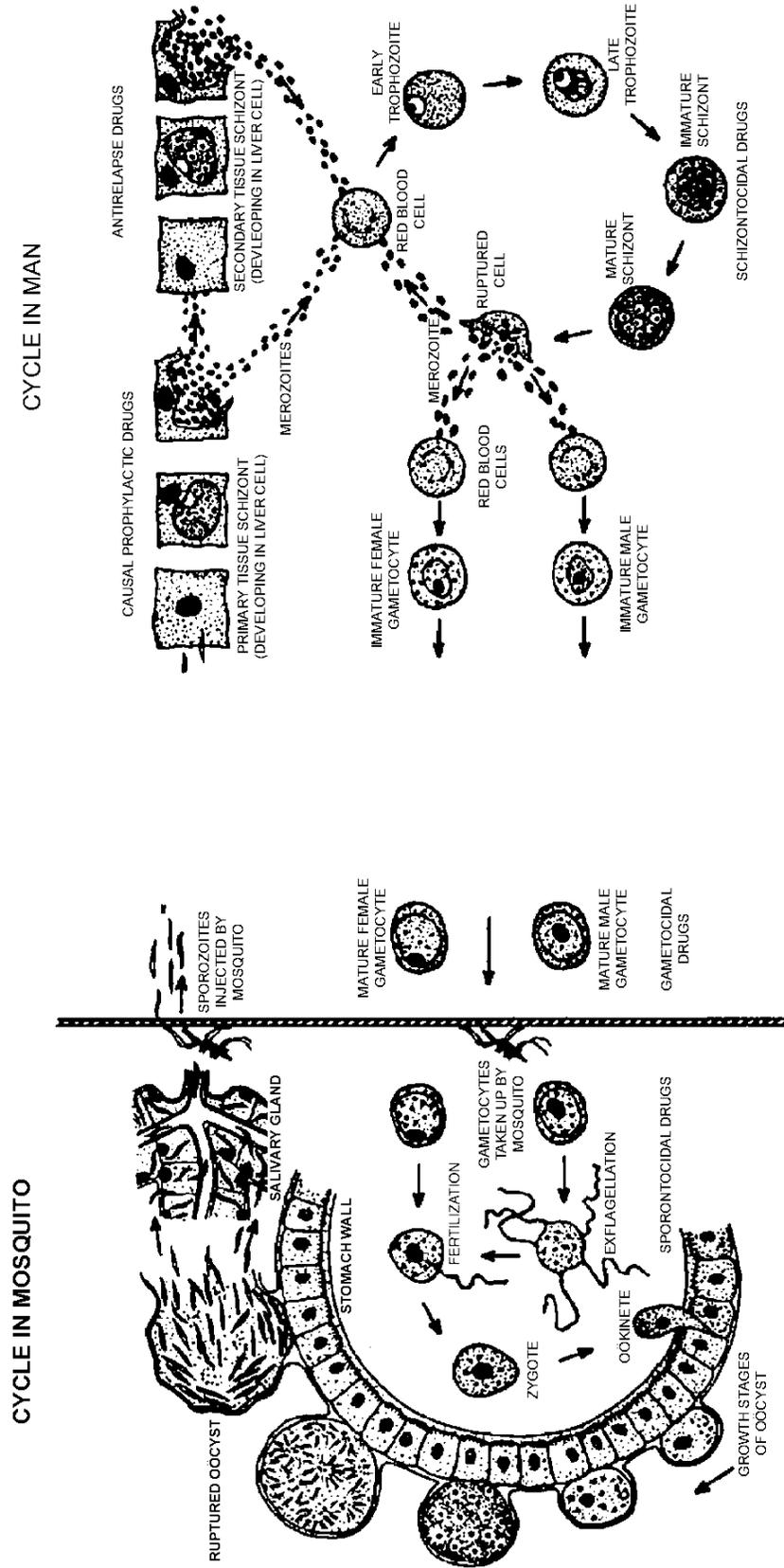
The number of imported cases, including drug-resistant strains of *P. falciparum*, has increased since the 1990s as more citizens of the region travel to malaria-endemic areas for work or recreation. Poland reported 37 imported cases in 1997, mainly from Africa. A study of 95 cases of malaria acquired by Polish citizens overseas between 1984 and 1993 found the majority of patients had neglected chemoprophylaxis while traveling in malaria-endemic areas.

The number of foreign residents in Central Europe is increasing. Of 660 foreigners from African countries south of the Sahara entering Czechoslovakia between 1986 and 1989, 10% were positive for *P. falciparum*. Nearly 75% of these were asymptomatic carriers. Infected mosquitoes can be accidentally transported in the cabin or cargo holds of international flights to malaria-free nations. From 1969 to 1996, 64 known cases of “airport malaria” were acquired by persons who worked or lived near an international airport in Europe.

Transmission Cycle(s). Humans are the only reservoir host of human malaria. Nonhuman primates are naturally infected by many *Plasmodium* species that can infect humans, but natural transmission is rare. Female mosquitoes of the genus *Anopheles* are the exclusive vectors of human malaria. *Plasmodium* species undergo a complicated development in the mosquito. When a female *Anopheles* ingests blood containing the sexual stages (gametocytes) of the parasite, male and female gametes unite to form a motile ookinete that penetrates the mosquito’s stomach wall and encysts on the outer surface of the midgut. Thousands of sporozoites are eventually released, and some of these migrate to the salivary glands. Infective sporozoites are subsequently injected into a human host when the mosquito takes a blood meal (Figure 2). The time between ingestion of gametocytes and liberation of sporozoites, ranging from eight to 35 days, is dependent on the temperature and the species of *Plasmodium*. Malaria parasites develop in the mosquito vector most efficiently when ambient air temperatures are between 25°C and 30° C. Parasite development is prolonged during cool seasons and at high altitudes, and may exceed the life expectancy of the vector. Adult life span varies widely

depending on species and environmental conditions. Longevity is an important characteristic of a good vector. Once infected, mosquitoes remain infective for life and generally transmit sporozoites at each subsequent feeding. Vector competence is frequently higher with indigenous strains of malaria. This decreases the likelihood that imported strains from migrants will become established.

Figure 2. LIFE CYCLE OF PLASMODIUM THE MALARIA PARASITE



Vector Ecology Profiles.

Worldwide, about 70 species of *Anopheles* transmit malaria to man, but of these, only about 40 are important vectors. There are a number of anopheline species that have been malaria vectors in the recent past and are still widely distributed in Central Europe. Although anophelines occur throughout the region, the areas of greatest concern are countries or provinces of the former Yugoslavia (Serbia, Montenegro, Croatia, Bosnia-Herzegovina, Macedonia, and Slovenia), the Czech Republic, Romania, and Greece.

Potential malaria vectors in the region include: *Anopheles atroparvus*, *An. claviger*, *An. labranchiae*, *An. maculipennis*, *An. melanoon*, *An. messeae*, *An. plumbeus*, *An. pseudopictus*, *An. sacharovi*, and *An. superpictus*. Appendix A.1 lists these mosquitoes and their known distribution in Central Europe.

General Bionomics. Female anopheline mosquitoes must ingest a bloodmeal in order for their eggs to develop. Feeding activity begins at dusk for many species, although many others feed only later at night or at dawn. Most anophelines feed on exposed legs, although some may feed on arms, ears or the neck. Infected females tend to feed intermittently and thus may bite several people. Eggs mature three to four days after the bloodmeal and are deposited one at a time, primarily in clean water with or without emergent vegetation, depending upon the mosquito species. A single female may deposit up to 200 eggs. Mosquito larvae feed on organic debris and minute organisms living in aquatic habitats. Oviposition sites include ground pools, stream pools, slow moving streams, animal footprints, artificial water vessels, and marshes. Deep water (over one meter in depth) is generally unsuitable for larval development. There are four larval instars, and one to two weeks are usually required to reach the nonfeeding pupal stage. The pupa is active and remains in the water for several days to a week prior to adult emergence. The life span of females is usually only two to three weeks, although under ideal conditions female mosquitoes may live for two to three months. Longevity of individual species varies. A long life span is an important characteristic of a good vector. The older the anopheline population is in an endemic area, the greater the potential for transmission. Males live only a few days. Females mate within swarms of males, usually one female per swarm. Males and females feed on plant sugars and nectar to provide energy for flight and other activities.

Adult Feeding, Resting, and Flight Behavior. *Anopheles* spp. that are strongly attracted to humans are usually more important as vectors than those species that are strongly zoophilic. *Anopheles* generally fly only short distances from their breeding sites. The flight range is the distance traveled from the breeding site over the course of the mosquito's lifetime. This is important when determining how far from military cantonments or human settlements to conduct larviciding operations. Vectors that feed and rest indoors are more susceptible to control by residual insecticides.

Specific Bionomics:

Anopheles atroparvus was originally considered to be a race of *An. maculipennis* but has been raised to species status by van Thiel. This species is a dark, short-winged form of *Anopheles* that does not hibernate. It is more abundant in northern Europe, although in Central Europe it is common along the Danube River in Romania, as well as in the lowlands of Serbia, Montenegro and the north-central part of Serbia (near Sabac). Larvae are found in ground pools or slow-moving, stagnant streams with a high saline and alkaline content. This species is more anthropophilic than *An. maculipennis*, but its spotty distribution helps to account for the highly focal nature of past malaria outbreaks in areas where it was the primary vector. *Anopheles atroparvus* is primarily an outdoor feeder but occasionally enters buildings. It usually rests outdoors after feeding and is not considered a particularly strong flier.

Anopheles claviger occurs in southern Bohemia in the Czech Republic, in the plains of Serbia, the Istrian Peninsula of Slovenia, Montenegro, and in Poland. Larval stages prefer ponds, marshes, cisterns, wells and rock pools in sunlight or shade. Adults feed on man outdoors and domestic animals in animal sheds and outdoors. Adults chiefly rest outdoors after feeding, but they can be collected in animal sheds. They usually fly only 200 to 300 m from larval breeding sites to attack animals, although they may be carried greater distances on cattle as they graze or return to animal sheds.

Anopheles labranchiae is a relatively uncommon species in Central Europe. Larvae can be found in fresh or brackish marshes, swamps, slow-moving streams and irrigated fields. Larvae tolerate warm water habitats, particularly in coastal areas. Adults feed on humans and domestic animals. They are endophilic and enter houses in large numbers. *Anopheles labranchiae* may rest indoors or outdoors after feeding. Its flight range in Central Europe is not known.

Anopheles maculipennis occurs widely throughout the region but is rare in Greece. Larvae frequently occur in oxbow swamps along the Danube River. Larvae also inhabit rice fields and freshwater and brackish marshes and lagoons. This is the dominant *Anopheles* species in highland areas. *Anopheles maculipennis* is zoophilic and feeds and rests in animal shelters as well as outdoors. Adults hibernate during the winter. Its flight range is generally one to two km from breeding sites.

In Central Europe, *An. melanoon* larvae develop in fresh, stagnant ground water, as well as brackish water habitats. Although its biting habits are not well known, it is considered to be primarily zoophilic. Consequently, it has low vector potential for malaria. However, it is prolific and can produce up to 500 eggs in its first gonotrophic cycle. Its flight range is estimated to be one to two km.

Anopheles messeae is distinguished by its long wings and occurs widely in Central Europe. It is the most abundant *Anopheles* species in the plains and river valleys of Slovenia, Serbia, Montenegro and the Czech Republic. Larvae develop in ground pools along the alluvial plain of the Danube and in low-lying coastal areas with standing water. This species is a marginal malaria vector due to its zoophilic feeding behavior. It feeds and rests indoors and outdoors. Adults hibernate during the winter. Its flight range is generally one to two km from breeding sites.

Anopheles plumbeus is an uncommon mosquito in Central Europe. It has been reported in the Czech Republic, Serbia and the Sava River Valley of Slovenia. Larvae inhabit treeholes, primarily in lowlands along river valleys, which would account for this species' sparse distribution. Its eggs are unusual among anophelines in that there are no floats, so the eggs hang perpendicularly in the water. This species is primarily zoophilic, and it rarely occurs indoors. It is not a strong flier.

Anopheles pseudopictus has been reported in the Danube River Delta where larvae inhabit extensive shallow, stagnant waters with abundant vegetation. This species feeds aggressively on animals indoors and outdoors, but rests outdoors. It feeds opportunistically on man. It is considered a good flier, often traveling up to one to two kilometers from its breeding habitat to feed. Adults hibernate in the open on vegetation. In Central Europe, *An. pseudopictus* is a poor malaria vector due to its low population densities and short life span. Adults rarely survive three gonotrophic cycles.

Anopheles sacharovi is a coastal species that has been reported from the Central European countries of Greece, Bosnia, Macedonia, Serbia, and Romania. Larvae develop in brackish ground pools and marshes. Adults of this species bite man and animals indoors and outdoors and often rest indoors or in animal shelters after feeding. In areas where it is abundant, *An. sacharovi* is considered a good malaria vector. It is known to be a strong flier in other regions, although no specific information on its flight range has been published for Central Europe.

In Central Europe, the larval habitats of *An. superpictus* include pools associated with muddy rivers or fast, shallow streams flowing over rocky stream beds. Vegetation may or not be present, although sunlit streams are preferred. Adults feeds on man and animals indoors and outdoors and rest indoors, in animal shelters or caves, or outdoors after feeding. *Anopheles superpictus* is considered an efficient malaria vector, but in this region it is an unlikely vector because of its scarcity.

Vector Surveillance and Suppression. Light traps are used to collect night-biting mosquitoes, but not all *Anopheles* spp. are attracted to light. The addition of the attractant carbon dioxide to light traps increases the number of species collected. Traps baited with animals, or even humans, are useful for determining feeding preferences of

mosquitoes collected. Adults are often collected from indoor and outdoor resting sites using a mechanical aspirator and flashlight. Systematic larval sampling with a long-handled white dipper provides information on species composition and population dynamics that can be used to plan control measures.

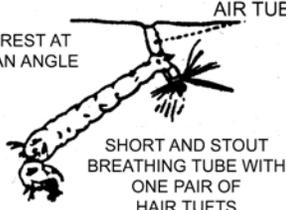
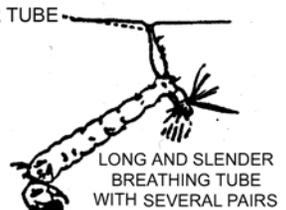
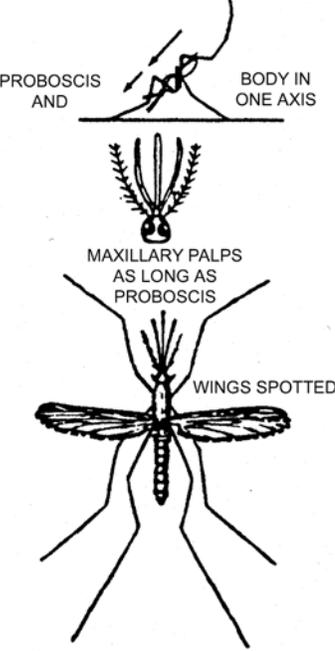
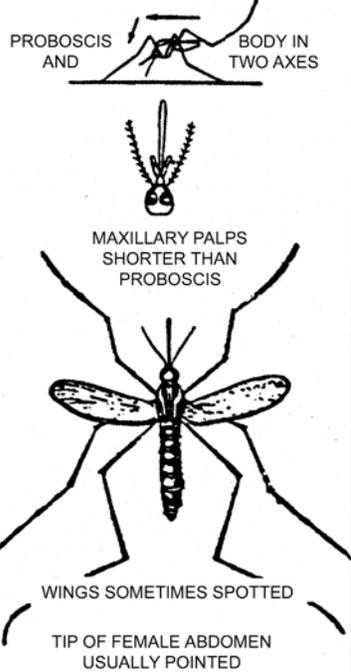
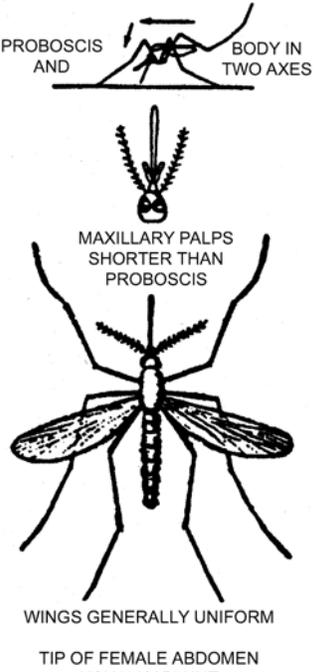
Anopheles mosquitoes have unique morphological and behavioral characteristics that distinguish them from all other genera of mosquitoes (Figure 3). *Anopheles* feed on the host with the body nearly perpendicular to the skin. Other genera of mosquitoes feed with the body parallel or at a slight angle to the skin. These characteristics can easily be used by inexperienced personnel to determine if *Anopheles* are present in an area.

Malaria suppression includes elimination of gametocytes from the blood stream of the human reservoir population, reduction of larval and adult *Anopheles* mosquito populations, use of **personal protective measures** such as skin repellents, permethrin-impregnated uniforms and bednets to prevent mosquito bites, and chemoprophylaxis to prevent infection. Specific recommendations for chemoprophylaxis depend on the spectrum of drug resistance in the area of deployment. Command enforcement of chemoprophylactic measures cannot be overemphasized. When Sir William Slim, British Field Marshal in Southeast Asia during World War II, strictly enforced chemoprophylactic compliance by relieving inattentive officers, malaria attack rates declined dramatically. During the Vietnam War, malaria attack rates dropped rapidly in military personnel when urine tests were introduced to determine if chloroquine and primaquine were being taken.

Many prophylactic drugs, such as chloroquine, kill only the erythrocytic stages of malaria and are ineffective against the latent hepatic stage of *Plasmodium* that is responsible for relapses. Therefore, even soldiers who take chloroquine appropriately during deployment can become infected. Individuals who are noncompliant with the prescribed period of terminal prophylaxis are at risk for late relapses upon their return to the United States. During the Vietnam War, 70% of returning troops failed to complete their recommended terminal prophylaxis. The majority of cases in military personnel returning from Operation Restore Hope in Somalia resulted from failure to take proper terminal prophylaxis. Application of residual insecticides to the interior walls of buildings and sleeping quarters is an effective method of interrupting malaria transmission when local vectors feed and rest indoors. Nightly dispersal of ultra low volume (ULV) aerosols can reduce exophilic mosquito populations. Larvicides and biological controls (e.g., larvivorous fish) can reduce populations of larvae at their aquatic breeding sites before adults emerge and disperse. Insecticides labeled for mosquito control are listed in TIM 24, Contingency Pest Management Guide. Chemical control may be difficult to achieve in some areas. After decades of malaria control, many vector populations are now resistant to insecticides (Appendix C. Pesticide Resistance in Central Europe). Sanitary improvements, such as filling and draining areas of

impounded water to eliminate breeding habitats, should be undertaken to the extent possible.

FIGURE 3. ANOPHELES, AEDES, AND CULEX MOSQUITOES

ANOPHELES	AEDES	CULEX
<p>EGGS</p>  <p>LAI D SINGLY HAS FLOATS</p>	<p>EGGS</p>  <p>LAI D SINGLY NO FLOATS</p>	<p>EGGS</p>  <p>LAI D IN RAFTS NO FLOATS</p>
<p>LARVAE</p>  <p>REST PARALLEL TO WATER SURFACE RUDIMENTARY BREATHING TUBE</p>	<p>LARVAE</p>  <p>REST AT AN ANGLE SHORT AND STOUT BREATHING TUBE WITH ONE PAIR OF HAIR TUFTS</p>	<p>LARVAE</p>  <p>LONG AND SLENDER BREATHING TUBE WITH SEVERAL PAIRS OF HAIR TUFTS</p>
<p>PUPAE</p> 	<p>PUPAE</p>  <p>PUPAE DIFFER SLIGHTLY</p>	<p>PUPAE</p> 
<p>ADULTS</p>  <p>PROBOSCIS AND BODY IN ONE AXIS MAXILLARY PALPS AS LONG AS PROBOSCIS WINGS SPOTTED</p>	<p>ADULTS</p>  <p>PROBOSCIS AND BODY IN TWO AXES MAXILLARY PALPS SHORTER THAN PROBOSCIS WINGS SOMETIMES SPOTTED TIP OF FEMALE ABDOMEN USUALLY POINTED</p>	<p>ADULTS</p>  <p>PROBOSCIS AND BODY IN TWO AXES MAXILLARY PALPS SHORTER THAN PROBOSCIS WINGS GENERALLY UNIFORM TIP OF FEMALE ABDOMEN USUALLY BLUNT</p>

The proper use of repellents and other **personal protective measures** is thoroughly discussed in TIM 36, Personal Protective Techniques Against Insects and Other Arthropods of Military Significance. The use of bednets impregnated with a synthetic pyrethroid, preferably permethrin, is an extremely effective method of protecting sleeping individuals from mosquito bites. Buildings and sleeping quarters should be screened to prevent entry of mosquitoes and other blood-sucking insects. The interior walls of tents and bunkers can be treated with permethrin to control resting vectors. See Appendix F for further information on **personal protective measures**.

C. West Nile Fever.

West Nile fever is a mosquito-borne illness characterized by fever, headache, muscular pain, and rash. Serious complications involve the liver and nervous system. The etiological agent, West Nile virus (WNV), is named after the district of Uganda where the virus was first isolated. It is a *Flavivirus* closely related to viruses causing Japanese encephalitis and St. Louis encephalitis. Infection with WNV is most often asymptomatic. The incubation period ranges from 1 to 6 days and clinically resembles a mild dengue-like illness. Recovery is complete but may be accompanied by long-term muscle pain and weakness. Permanent sequelae have not been reported. Most fatal cases have occurred in patients over 50 years old.

Military Impact and Historical Perspective. WNV was isolated in 1937 and was one of the earliest human arboviral infections to be documented. Undoubtedly, WNV has been the cause of many cases classified as fevers of unknown origin in military personnel. In view of the mild illness and the infrequent occurrence of epidemics, the military impact of this virus is likely to be minor compared with other diseases in Central Europe. Infection with WNV will complicate diagnoses by medical personnel, since West Nile fever cannot be clinically distinguished from many other arboviral fevers.

Disease Distribution. WNV has been isolated in many areas of Africa, Europe, India and Pakistan, as well as from North America in 1999. Viral isolations from vertebrate hosts and mosquitoes, and serological surveys of humans and suspected reservoir hosts indicate that WNV is circulating throughout Central Europe, but the incidence in humans is unknown. A large outbreak occurred in the summer of 1996 in and near Bucharest, Romania, with more than 800 clinical cases and a case-fatality rate approaching 10%. This epidemic was the first important outbreak of West Nile fever recorded in Europe. Several human cases of West Nile fever also occurred in the Czech Republic in July 1997, after heavy rains caused extensive floods along the Morava River. See Figure 4 for the distribution of outbreaks of West Nile fever in Central Europe.

West Nile fever occurs during the period of maximum activity of mosquito vectors, usually June through September. Environmental factors, including human activities that enhance vector populations (irrigation, heavy rains followed by flooding, higher than

FIGURE 4. AREAS OF RECENT OUTBREAKS OF WEST NILE FEVER IN CENTRAL EUROPE (DARK SHADING)



normal temperatures), increase the potential for an outbreak of this and other mosquito-borne diseases.

Transmission Cycle(s). WNV has been isolated from numerous wild birds and occasionally from mammals. Serological surveys have demonstrated WNV antibodies in wild and domestic bird species, wild mammals such as lemurs, rodents and bats, and domestic animals such as camels, horses, mules, donkeys, goats, cattle, water buffalo, sheep, pigs and dogs. However, birds are considered to be the primary reservoir for WNV and may reintroduce the virus during seasonal migrations. Birds usually do not show any symptoms when infected with WNV, though illness and death have been observed in pigeons and corvids (crows). Infections in most mammals fail to produce viremias high enough to infect potential vectors. WNV has been isolated from several species of mosquitoes in nature, especially *Culex* spp., which are recognized as the primary vectors. WNV has also been recovered from bird-feeding ticks and mites, and experimental transmission of WNV has been observed in *Ornithodoros* spp. and several species of hard ticks. A natural bird-tick zoonotic cycle has been suggested, but the role of ticks in the natural transmission of WNV has not been well defined. Mosquitoes are clearly implicated in the transmission of WNV to humans. WNV replicates quickly in mosquitoes when temperatures exceed 25°C. Infected mosquitoes can transmit WNV for life. Experimental transmission of WNV by *Aedes albopictus* has been reported, and the spread of this species from Albania and Greece to other areas of Central Europe may increase the risk of transmission to humans.

In Europe WNV circulation exhibits rural and urban cycles of transmission. Rural foci of WNV infections are mainly situated in wetland ecosystems (river deltas and flood plains) and involve bird-feeding mosquitoes. Ticks may substitute as vectors and in certain dry and warm habitats lacking mosquitoes. The urban cycle consists of domestic birds and mosquitoes that feed on both birds and humans, primarily members of the *Culex pipiens* complex. The principal cycle is rural, but the urban cycle predominated in Bucharest during the 1996 outbreak.

Vector Ecology Profiles. West Nile virus has been isolated from *Culex pipiens* (in Bulgaria, the Czech Republic, and Romania), *Culex modestus* in Slovakia, and *Aedes cantans* in Slovakia and Moravia.

Aedes cantans chiefly occurs along the edges of forests or in thinned forests. This species deposits its eggs singly or in small numbers on moist soil and wet leaf litter near water subject to flooding. Favored oviposition sites include ground pools or ditches with fallen leaves or sparse vegetation but without filamentous algae. *Aedes cantans* overwinters in the egg stage; eggs hatch when flooded during the spring. Eggs can remain viable for more than four years at high relative humidity. Larvae are often associated with those of *Ae. annulipes*, *Ae. communis*, *Ae. punctator* and *Ae. rusticus*.

Adults are fierce outdoor feeders on large domestic animals and humans but rarely feed or rest indoors. Adults seldom travel far from their larval habitats to feed.

Culex modestus has a fairly restricted habitat compared with *Cx. pipiens*, though the two species show similar oviposition behavior. Larvae occur in small fishponds, marshy areas, and swamps in south-central Europe. The development time of larval instars is also similar to *Cx. pipiens* and is dependent on temperature. Adults are zoophilic and feed and rest outdoors. Adults feed primarily on birds and waterfowl. This species often overwinters in *Phragmites* reed piles or other dead vegetation around breeding sites.

Culex pipiens is widespread and abundant throughout Central Europe. Adults usually prefer to feed on birds but readily feed on humans and large animals like cattle and goats. They feed early in the evening, usually within two hours of sunset, although feeding continues throughout the night. Adults are strong fliers and will travel three to five km from breeding sites to find a bloodmeal. This species is an annoying biter and produces a high-pitched buzzing sound that can easily be heard. Members of the *Cx. pipiens* complex feed and rest indoors or outdoors. Adults are more endophilic in the late fall. Three or four days after a bloodmeal, *Cx. pipiens* deposits egg rafts containing 75 to 200 eggs on the water surface. Common oviposition sites include cisterns, water troughs, irrigation spillovers, wastewater lagoons, and swamps. Eggs hatch two to four days after deposition. Larvae of the *Cx. pipiens* complex generally prefer ground pools with high concentrations of organic matter or swamps with emergent vegetation. Polluted water from septic systems is an ideal breeding site for this complex. In Bucharest, Romania, and nearby suburbs flooded basements are an important breeding habitat for this mosquito. Larval development requires seven to nine days at a temperature range of 25 to 30 C. At lower temperatures, larval stages may require 15 to 20 days. The pupal stage lasts about two days. Adults of *Cx. pipiens* occur from May to October in most of Central Europe, although they may be found for another month or more in Greece, or even year-round in highly focal areas where sewage effluent keeps breeding sites warm. Adults usually display two population peaks, one in May and another in September.

Vector Surveillance and Suppression. Epidemics of West Nile fever are infrequent, and public health officials in Central European countries can rarely justify continued long-term surveillance for virus activity when considering other health care demands. Reduction of mosquito populations by ULV spraying may be useful as a means of disease control. The most feasible long-term control strategies involve reducing vector breeding by environmental management techniques. **Personal protective measures** to prevent mosquito bites are the most practical means of avoiding infection with WNV. Consult TIM 13, Ultra Low Volume Dispersal of Insecticides by Ground Equipment; TIM 24, Contingency Pest Management Guide; and TIM 40, Methods for Trapping and Sampling Small Mammals for Virologic Testing. Also see vector surveillance and suppression for malaria.

D. Sindbis Virus.

Sindbis virus belongs to the genus *Alphavirus*, family *Togaviridae*. It is closely related to the Western equine encephalitis complex. The incubation period is less than a week and symptoms may include fever, headache, rash, and joint pain. Syndromes resulting from Sindbis virus infection have been called Ockelbo disease in Sweden, Pogosta disease in Finland, and Karelian fever in the former Soviet Union. No fatal cases have been reported.

Military Impact and Historical Perspective. Sindbis virus was first isolated in 1952 from *Culex* mosquitoes collected in the village of Sindbis north of Cairo. It was subsequently reported from Europe, Asia, sub-Saharan Africa and Australia. A role in human disease was recognized in 1961 when Sindbis virus was isolated from patients with fever in Uganda. Human epidemics due to Sindbis virus were documented in South Africa in the late 1960s, and clusters of cases with fever, arthralgia and rash have been observed in Sweden. Although outbreaks of Sindbis virus have caused significant human morbidity in areas of northern Europe, this disease is expected to have a minor impact on military operations in Central Europe.

Disease Distribution. Sindbis virus is one of the most widely distributed of all known arboviruses. Studies have demonstrated Sindbis virus transmission in most areas of the Eastern Hemisphere. Viral isolations and serological surveys of birds, small mammals, domestic animals and humans indicate that Sindbis virus is enzootic throughout Central Europe. Seroprevalence found in most studies is generally low, < 3%.

Transmission Cycle(s). A wide range of wild and domestic vertebrate species are susceptible to infection with Sindbis virus. Most experimentally infected wild birds easily produce viremias high enough to infect several different species of mosquitoes. Wild and domestic birds are considered the main enzootic reservoir. Although several species of domestic mammals can become infected with Sindbis virus, there is no evidence that these infections result in significant illness. Evidence implicates bird-feeding mosquitoes of the genus *Culex* as the vectors of Sindbis virus in enzootic and human infections. However, viral isolations and transmission experiments have shown that *Aedes* spp., which are less host specific and feed readily on both birds and humans, may be important as vectors linking the enzootic cycle and human infection. Mechanisms that allow the virus to overwinter and survive between periods of enzootic transmission have not been identified. Outbreaks of Sindbis fever epidemics in northern Europe are believed to be caused by the introduction of the virus from Africa to Europe by migratory birds.

Vector Ecology Profiles. Essentially the same vectors that transmit Sindbis virus in Russia and Scandinavia are present in Central Europe, including *Culiseta morsitans*,

Culex pipiens, *Cx. torrentium* and *Aedes cinereus*. The bionomics and behavior of *Cx. pipiens* are described under West Nile.

Aedes cinereus acts as a bridge vector between birds and humans and is widely distributed in Central Europe. Eggs hatch rapidly after inundation with water. Larvae generally occur in deep or partially shaded water in thinned forests, at forest edges, in meadows or swamps bordered by shrub thickets, and in pools with little vegetation. This species is referred to as a snow-melt mosquito, since larval habitats are often associated with melting snow. Larval development is often extended for several weeks because of cool water temperatures. Larvae often occur in association with *Culex territans*. Adults of *Ae. cinereus* may be extremely numerous and are crepuscular or daytime biters. They rest in grasses in thinned forests or at forest edges, biting humans and animals as they enter these areas. This species usually feeds close to its larval breeding sites and rarely travels more than 1.5 km. In the Slovak Republic, peak activity of *Ae. cinereus* adults occurs in late July.

Culiseta morsitans is widely distributed in Europe. This is mainly a forest mosquito that prefers to feed on birds. Larval stages occur in moderately saline, shaded ground pools, or in cool, slow-moving water that is shaded and usually contains decaying leaves at the bottom. Normally there is one generation per year. Larval diapause in permanent bodies of water is the principal overwintering mechanism, although diapause in the egg stage has also been reported. This species is rare inside human habitations. Adults rest in grass at the edges of forests and usually feed close to their larval breeding sites. They bite wild and domestic animals, birds and, occasionally, humans.

The distribution of *Culex torrentium* is limited to the Czech and Slovak Republics, Romania and Poland. This species is morphologically similar to *Cx. pipiens* and can only be distinguished by examination of the male terminalia. Larvae occur in a wide variety of natural and manmade breeding sites, including the perimeters of lakes, marshy areas, permanent ponds and swamps bordered by *Phragmites* reeds, stagnant water in ditches, and artificial containers. Larvae are often found in polluted water in association with those of *Cx. pipiens*. Adults occur from May to October, with peak populations appearing in June and July. Inseminated females overwinter.

Vector Surveillance and Suppression. See West Nile fever and malaria.

E. California Group Viral Infections.

California serogroup infections are mosquito-borne diseases characterized by a wide spectrum of clinical manifestations, ranging from a simple febrile illness to life-threatening encephalitis. Tahyna, the only California group virus isolated from Central Europe, produces an influenza-like illness lasting three to five days. The onset is sudden,

with fever, sore throat and generalized malaise. Additional symptoms associated with Tahyna virus infection include cough, pharyngitis, conjunctivitis, headache, nausea, generalized weakness and, rarely, meningoencephalitis or bronchopneumonia. No residual sequelae or deaths have been recorded due to Tahyna virus infection.

Military Impact and Historical Perspective. The first California group virus was isolated in 1943 from *Aedes melanimon* mosquitoes collected in Kern County, California. Subsequent isolations of related viruses and their association with human infections led to the recognition that members of this serogroup were etiological agents of human encephalitis. Tahyna virus was first isolated in 1958 from *Aedes* mosquitoes in southeastern Czechoslovakia. It has now been isolated from several countries, most in Central Europe. The military impact of Tahyna viral infections on military operations should be minimal due to the mild nature of the illness. Distinguishing this virus from other febrile diseases on clinical grounds would be difficult.

Disease Distribution. Foci of Tahyna virus have been found from Finland to Tajikistan. The center of Tahyna virus distribution in Central Europe lies within the Pannonian plain. This steppe-like region contains soils with a high salt content and covers parts of Austria, southern Czechoslovakia, Hungary, Serbia and Romania.

Transmission Cycles. A large number of vertebrate species have been experimentally infected with Tahyna virus and examined for viremia. Viremia has been observed in almost all mammal species tested except bats. Tahyna virus does not produce detectable viremias in birds, amphibians or reptiles. The main amplification hosts for Tahyna virus in Central Europe are European hares and rabbits. Under natural conditions, no clinical manifestations have been described in animals infected with California group viruses. In Europe, Tahyna virus appears to have a number of overwintering mechanisms. The virus is transmitted transovarially in *Aedes* mosquitoes and it may overwinter in adult mosquitoes. European hedgehogs infected with Tahyna virus and placed in hibernation for 140 days develop a viremia subsequent to awakening that is sufficient to infect mosquitoes.

Vector Ecology profiles. In Central Europe, Tahyna virus has been isolated from mosquitoes of five genera. The majority of isolates have been obtained from *Aedes* species, primarily *Aedes vexans* and *Ae. caspius*. The pattern of viral isolates from mosquitoes throughout Eurasia indicates that strains of Tahyna virus utilize different vector species in different geographical areas.

The principal vectors of this virus in Central Europe are *Ae. vexans*, *Ae. sticticus* and *Ae. cantans*. *Aedes caspius* is an important vector in the eastern portion of the Slovak Republic, while *Ae. cinereus* has been identified as a secondary vector in Moravia, Czech Republic. However, the virus has been isolated in the field from several other species of

mosquitoes, as well as a number of species of *Culicoides*. *Culiseta subochrea* and *Culex modestus* have been reported as vectors in southern Moravia. The virus has been isolated from *Cx. pipiens* in Romania. Pools of *Culicoides achrayi*, *C. grisescens*, *C. heliophilus*, *C. obsoletus*, *C. impunctatus* and *C. pallidicornis* have yielded two field isolations of Tahyna virus in the Czech Republic. Since these isolates came from mass pooling of mixed species, it is uncertain which, if any, of these biting midges are significant vectors.

Of the four principal vectors, *Ae. vexans* is the most widely distributed and is present or suspected in nearly every country in the region. *Aedes cantans* and *Ae. sticticus* have a more central distribution. *Aedes caspius* has a slightly more coastal and southern distribution, although it occurs in Poland. *Culex pipiens* is also widely distributed and is probably present in every country in the region. *Culex modestus* and *Culiseta subochrea* appear to have a more inland rather than coastal distribution. The distribution of mosquitoes in Central Europe appears in Appendix A.1.

Aedes caspius deposits its eggs singly or in small groups directly on the surface of shallow, stagnant, sunlit pools with muddy bottoms and little or no vegetation. Larvae emerge two to three days after deposition. Breeding sites colonized include isolated stream pools, ground pools, coastal impoundment areas, inland lakes with high salinity, and overflow water from irrigation projects. Although this species is frequently found alone, it is sometimes associated with *Uranotaenia unguiculata* in freshwater habitats. *Aedes caspius* is an opportunistic feeder that attacks birds and large mammals close to its breeding habitats. Hosts include cattle, deer, sheep, and humans. It feeds chiefly outdoors during the daytime but may feed in the evening. Females occasionally develop eggs autogenously after feeding only on plant nectars.

Aedes sticticus is found in forested floodplains and river deltas and may also inhabit forest-steppes. Like all floodwater *Aedes*, it overwinters in the egg stage and may survive up to three years in a desiccated state. Larvae emerge in the spring puddles and pools formed by melting snow or river flooding. Partially shaded puddles and ground pools covered by fallen leaves are ideal habitats. Adults emerge in large numbers and feed aggressively on humans and animals. *Aedes sticticus* feeds and rests outdoors and will feed throughout the day but prefers the evening hours. It is a strong flier and may travel up to 16 km from its breeding sites to find hosts.

Aedes vexans also inhabits floodplains and river deltas and lays its eggs on the edges of slopes and the mud of river beds where seasonal inundations occur. Larvae are also found in ground pools, puddles, ditches, and hoofprints free of filamentous algae. Eggs hatch at a water temperature between 14 and 16°C. Larval stages take seven to 14 days to complete their development depending on temperature. The optimal temperature range is 28 to 30°C. Adults are fierce human biters that feed and rest indoors or outdoors. They are strong fliers and may travel 10 to 20 km from their breeding sites.

Culiseta subochrea is widespread throughout the region and primarily inhabits lightly forested plains. Females deposit approximately 200 eggs in a raft on the surface of partially shaded pools, cisterns, ditches or containers. Breeding sites often contain vegetation, high quantities of organic debris, and moderate salinity. Adults are zoophilic and feed primarily on birds and large mammals. They rarely bite humans. Adults feed and rest outdoors, close to their larval breeding sites. Adults overwinter, often in animal sheds. Larval diapause has been reported in northern areas of Central Europe.

Culex modestus often occurs in large numbers in forest-steppe, mixed forests, and clearings in wooded areas. Larvae inhabit reed thickets around fish ponds, marshy areas and swamps in south-central Europe. Larvae can tolerate foul water and frequently occur in association with those of *Cx. pipiens* and members of the *Anopheles maculipennis* complex. Egg rafts are deposited on the surface of breeding sites. Larval development is similar to that of *Cx. pipiens* and is dependent on temperature. Adults are primarily zoophilic and rest and feed outdoors during twilight and evening hours. This species feeds on hedgehogs, birds and waterfowl near its breeding sites. However, *Cx. modestus* is also a fierce human biter and may feed even in daylight. Adults are more abundant from July through September. Adults often overwinter in *Phragmites* reed piles or other dead vegetation occurring around breeding sites.

Culex pipiens and *Ae. cantans* are discussed under West Nile fever.

Vector Surveillance and Suppression. Control of larvae or adults of these species over large areas is usually impractical or uneconomic. Floodwater mosquitoes such as *Ae. vexans* can emerge in vast numbers over such large areas that aerial dispersal of ULV aerosols is required to reduce their populations. Vegetation frequently prevents aerially dispersed sprays from reaching breeding sites and resting adults. Use of the **DoD repellent system** is the best means of protection from these mosquitoes.

F. Dengue Fever. (Breakbone fever, Dandy fever)

Dengue is an acute febrile disease characterized by sudden onset, fever for 3 to 5 days, intense headache, and muscle and joint pain. It is commonly called “breakbone fever” because of the severity of pain. There is virtually no mortality in classical dengue. Recovery is complete, but weakness and depression may last several weeks. Dengue is caused by a *Flavivirus* and includes four distinct serotypes (dengue 1, 2, 3 and 4). Recovery from infection with one serotype provides lifelong immunity from the same serotype but does not confer protection against other serotypes. Dengue hemorrhagic fever (DHF) and associated dengue shock syndrome (DSS) were first recognized during a 1954 epidemic in Bangkok, Thailand. DHF/DSS have spread throughout Southeast Asia, Indonesia and the southwest Pacific, Latin America and the Caribbean. DHF requires

exposure to two serotypes, either sequentially or during a single epidemic involving more than one serotype. DHF is a severe disease that produces high mortality in children.

Military Impact and Historical Perspective. Dengue virus was first isolated and characterized in the 1940s, but dengue fever can be identified clinically from the 18th century. Epidemics of dengue are noted for affecting large numbers of civilians or military forces operating in an endemic area. Outbreaks involving 500,000 to two million cases have occurred in many parts of the world. During World War II, the incidence of dengue was largely restricted to the Pacific and Asiatic theaters. Only scattered cases of dengue were reported from other theaters, including North Africa. Campaigns in the Pacific were marked by dengue epidemics, and throughout the war the US Army experienced nearly 110,000 cases. At Espiritu Santo in the Pacific, an estimated 25% of US military personnel became ill with dengue, causing a loss of 80,000 man-days. Dengue was an important cause of febrile illness among US troops during Operation Restore Hope in Somalia. In recent years dengue, especially DHF, has been expanding throughout the world. Thirty to 50 million cases of dengue are reported annually.

Disease Distribution. Dengue is present in nearly all tropical countries. Its distribution is congruent with that of its primary vector, *Aedes aegypti*, between 40° N and 40° S latitude. Epidemics generally coincide with the rainy season and high mosquito populations. Increasing urbanization and discarded litter have increased breeding habitats for dengue vectors. Transmission of dengue has not been reported in Central Europe for many years, although dengue antibodies were found in residents of Albania and Croatia in serological studies conducted during the late 1980s.

Transmission Cycle(s). Dengue virus is primarily associated with *Aedes* mosquitoes in the subgenus *Stegomyia*. The virus is maintained in a human-*Ae. aegypti* cycle in tropical urban areas. A monkey-mosquito cycle serves to maintain the virus in sylvatic situations in Southeast Asia and West Africa. Mosquitoes are able to transmit dengue virus eight to 10 days after an infective blood meal and can transmit the virus for life. Dengue virus replicates rapidly in the mosquito at temperatures above 25°C.

Vector Ecology Profiles.

Aedes aegypti, the primary vector in most endemic areas, has been reported from the Central European countries of Albania, Bosnia, Bulgaria, Greece and Macedonia. This species is more common in cities or villages than in rural areas. *Aedes aegypti* deposits its eggs singly or in small groups of two to 20 above the water line of its habitat. Larvae emerge after eggs have been submerged for four or more hours. *Aedes aegypti* larvae live in artificial water containers, including flowerpots, cisterns, water jugs, and tires. Larvae prefer relatively clean and clear water. They develop quickly in warm water, maturing to the pupal stage in about nine days. Pupae remain active in the water

container until adult emergence, one to five days after pupation. *Aedes aegypti* rarely disperses more than 50 m from its breeding site, but over several days, it can disperse as far as 500 to 600 m. It does not fly when winds exceed five km per hour.

Aedes aegypti prefers human hosts and feeds primarily around human habitations. It is a diurnal feeder and readily enters homes. *Aedes aegypti* is not attracted to light; rather, it responds to contrasting light and dark areas presented by human dwellings. When feeding outdoors, it prefers shaded areas. It feeds on the lower legs and ankles, increasing its biting activity when temperatures and humidity are high. It is easily disturbed when feeding and, because it feeds during the day, is often interrupted by the movements of its host. This behavior results in multiple bloodmeals, often taken within the same dwelling, which increases transmission of virus.

The increase in the transport of freight and passengers by ship and air has allowed vectors and pathogens to spread quickly and easily over large distances. The introduction of *Aedes albopictus* to many new areas through the shipment of used tires to recapping plants has alarmed public health officials. *Aedes albopictus* has been spreading rapidly in the Mediterranean since its accidental introduction into Italy in 1990. It has been reported from Albania and Greece, and this important vector may spread to other areas of Central Europe where the climate is favorable for its survival, especially the former Republic of Yugoslavia. Its arrival in Albania from China in the mid-70s was the first recorded infestation of *Ae. albopictus* outside the Oriental and Australian regions.

Aedes albopictus is second only to *Ae. aegypti* in importance as a vector of dengue. It is more common in rural than urban areas. It has larval and adult feeding habits similar to *Ae. aegypti* but is more commonly found breeding in natural containers, such as tree holes, leaf axils, and fallen fruit husks. It is a slightly stronger flier than *Ae. aegypti*. *Aedes albopictus* is strongly anthropophilic but has a broader host range than *Ae. aegypti*.

Aedes caspius deposits its eggs singly or in small groups directly on the surface of shallow, stagnant, sunlit pools with muddy bottoms and little or no vegetation. Larvae emerge two to three days later. Breeding sites colonized include isolated stream pools, ground pools, coastal impoundment areas, inland lakes with high salinity, and overflow water from irrigation projects. Although this species is frequently found alone, it is sometimes associated with *Uranotaenia unguiculata* in freshwater habitats. *Aedes caspius* is an opportunistic feeder that attacks birds and large mammals close to its breeding habitats. Hosts include cattle, deer, sheep, and humans. It chiefly feeds outdoors during the daytime but may feed in the evening. Females occasionally develop eggs autogenously after feeding only on plant nectars. If dengue outbreaks occur in Central Europe, *Ae. caspius* could be a significant vector.

Vector Surveillance and Suppression. Landing rate counts provide a quick relative index of adult abundance. The number of mosquitoes that land on an individual within a short period of time, usually one minute, is recorded. Resting collections consist of the systematic search for dengue vectors in secluded places indoors, such as in closets and under furniture. Resting collection studies performed with mechanical aspirators are an efficient but labor-intensive means of evaluating adult densities. Densities are recorded either as the number of adult mosquitoes per house or the number of adult mosquitoes collected per unit of time.

Several indices have been devised to provide a relative measure of the larval populations of *Ae. aegypti*. The house index is the percentage of residences surveyed that have containers with larvae. The container index is the percentage of containers at each premise that have larvae. The Breteau index is more widely used and is the number of positive containers per 100 premises. There is a risk of dengue transmission when the Breteau index goes above five, and emergency vector control is indicated when the index exceeds 100. Adult egg-laying activity can be monitored using black oviposition traps. Ovitrap are especially useful for the early detection of new infestations in areas from which dengue vectors had been eliminated.

Control of dengue fever is contingent upon reducing or eliminating vector populations. Ground or aerial applications of insecticidal aerosols have been relied upon to reduce adult populations during epidemics of dengue. Many vector control specialists have questioned the efficacy of ULV adulticiding. In some outbreaks of dengue fever, ULV dispersal of insecticides has had only a modest impact on adult mosquito populations. *Aedes aegypti* is a domestic mosquito that frequently rests and feeds indoors and therefore is not readily exposed to aerosols. The sides of large storage containers should be scrubbed to remove eggs when water levels are low. Water should be stored in containers with tight-fitting lids to prevent access by mosquitoes. A layer of oil will prevent mosquito eggs from hatching and will kill the larvae. The elimination of breeding sources, such as old tires, flowerpots, and other artificial containers, is the most effective way to reduce mosquito populations and prevent dengue outbreaks. In Singapore, passage of sanitation laws and their strict enforcement to eliminate breeding sites reduced the house index for *Ae. aegypti* larvae from 25% to 1%. Proper disposal of trash, bottles and cans at military cantonments must be rigidly enforced. The individual soldier can best prevent infection by using **personal protective measures** during the day when vector mosquitoes are active. Wear permethrin-impregnated BDUs and use extended-duration DEET repellent on exposed skin surfaces (see TIM 36).

G. Tick-borne Encephalitis.

Tick-borne Encephalitis (TBE), caused by a complex of flaviviruses, actually comprises two clinically different diseases, Far Eastern TBE, also known as Russian spring-summer encephalitis, and Central European TBE, also known as biphasic meningoencephalitis, or

diphasic milk disease. Human disease of the Far Eastern subtype is usually more severe in the acute phase and is associated with a higher rate of chronic nervous system sequelae than the Central European subtype. Far Eastern TBE has been a significant public health problem in central Russia since the 1930s. Case fatality rates have been as high as 40% in endemic areas. The case fatality rate for Central European TBE ranges from 1 to 5%. The term TBE is used to identify the broad spectrum of clinical syndromes caused by the virus, ranging from a simple febrile illness to severe central nervous system infection that may be fatal. However, about 80% of serologically documented infections are inapparent. The incubation period ranges from seven to 14 days and is followed by fever, headache, muscle pain, nausea, vomiting and photophobia. In about 30% of patients, the disease progresses to encephalitis, paralysis or even death. The highest mortality and most serious neurological sequelae occur in people over 40.

Military Impact and Historical Perspective. Illness of the Far Eastern subtype was first described in 1937 during an epidemic in the Russian Far East. The European subtype was clinically defined in 1948 during an epidemic in Central Bohemia. Although TBE virus exists in discrete foci, it is widespread throughout Central Europe, and military personnel would experience a high level of exposure to vector ticks. TBE should be considered a serious threat to personnel deployed to the region.

Disease Distribution. The tick-borne encephalitides occur along the southern part of the forest belt of temperate Eurasia, from the Atlantic to the Pacific Ocean. The Far Eastern subtype occurs in Siberia, the southern republics of the former Soviet Union, and Northeastern China. The European subtype occurs in Europe, including Russia west of the Ural Mountains. The largest number of cases in recent years was observed in the Urals and in western Siberia. In the 1950s and 1960s, TBE was primarily an occupational disease contracted by forest workers and farmers in rural areas. During the 1970s and 1980s, up to 70% of reported cases were in urban dwellers that became infected during recreational outings in forests, usually within three to eight km of towns.

TBE is focally distributed throughout Central Europe in ecological conditions that are favorable to the primary vector, *I. ricinus*, and small rodent reservoirs of the virus. Ideal habitats include mixed deciduous forests (particularly oak) extending into brushy forest edges and meadows, and along stream and river valleys. Enzootic areas are usually less than 1000 m in elevation. Suburban forests and urban forested parks are frequently foci of TBE.

Albania: Areas of greatest risk include the southern districts of Gjirokaster and Permet, the central district of Tirane, and the eastern district of Librazhd.

Bosnia and Herzegovina: Highest risk of transmission occurs along oak-forested river basins, particularly around Zenica (central Bosnia), west of Tuzla (eastern Bosnia), areas

surrounding and to the southwest of Gorazde (southeast Bosnia), and along the Adriatic coast between Capljina and Dubrovnic (extreme southwest Bosnia).

Bulgaria: High levels of antibodies to TBE virus have been found in goats and sheep in central Bulgaria.

Croatia: Risk of transmission is high along oak-forested river basins, primarily in the areas between the Drava and Sava Rivers, but is low along the Adriatic coast and on the Adriatic islands.

Czech Republic: TBE is known locally as “Roznava disease.” Enzootic areas include Bohemia (especially areas south of Prague and throughout the Vltava River Basin, and near Plzen) and Moravia (particularly in the south, including the area bordered by the cities of Brno, Breclav, and Znojmo, and areas around the northern city of Ostrava).

Hungary: Enzootic areas include western (Gyor-Sopron, Somogy, Vas, Veszprem and Zala Counties) and northwestern (Komarom and Nograd Counties) Hungary.

Greece: TBE is focally distributed countrywide, although up to 14% of the population in southern Greece was seropositive during the late 1980s.

Macedonia: Recent seroprevalence data are not available, although Macedonia has historically reported the lowest incidence of TBE in the former Republic of Yugoslavia.

Poland: TBE is widely distributed countrywide, but the risk of transmission is highest in the northeast, particularly in areas bordering Lithuania and Belarus.

Romania: Enzootic foci are concentrated in the Tulcea District and in areas of Transylvania at the base of both the Carpathian Mountains and the Transylvanian Alps.

Slovak Republic: Elevated risk of transmission occurs in western Slovakia (including the Zahorske lowland, the Vah River Valley, and northward to the district of Povazska, the Low Carpathian Mountains, Tribec and Vtacnik ridges, the Nitran-Pohron area, and the Kovacov Hills) and southern Slovakia including the Pannonian Plain. Enzootic areas also occur in central Slovakia (including the Krupin Hills) and in eastern Slovakia (including the Slovak Karst and Slanske Hills).

Serbia and Montenegro: Enzootic foci are located in northeastern Serbia around Belgrade. Additional foci exist in west and southwest Serbia.

Slovenia: Slovenia has the highest risk of TBE in the former Republic of Yugoslavia. Persistent enzootic foci exist in the hilly and mountainous regions, as well as the plains

of Slovenia. TBE antibody seroprevalences in endemic areas have exceeded 30%. Officially, 200 to 300 cases of TBE are reported per year despite an active immunization program. Very few cases have been reported from the Adriatic Coast.

Transmission Cycle(s). Humans acquire infection from bites of infected ticks or by crushing infected ticks on abraded skin. Infection can also be acquired from the consumption of raw milk or unpasteurized milk products, usually from goats. Natural infections have been recorded in 16 species of ixodid ticks. *Ixodes ricinus* is the primary vector in Central Europe and also the primary reservoir of the virus. Up to 4% of *I. ricinus* have been found infected with TBE virus in the Czech Republic. The virus overwinters in infected ticks and is passed transstadially and transovarially. Important vertebrate hosts that amplify the virus are hedgehogs, shrews, field mice and voles. Over 20% of some *Apodemus* spp. and *Clethrionomys* spp. have been found with antibodies to TBE virus in enzootic areas of Central Europe. Besides small mammals, in natural TBE foci the most frequent hosts of immature ixodid ticks are birds, especially those species that spend large amounts of time searching for food or nesting on the ground. Avian hosts are not important as reservoirs of TBE virus, but migrating birds disperse vector ticks over long distances. There are reports of illness and death in dogs, calves, lambs, goats, wild birds and rodents after natural infection.

Vector Ecology Profiles.

The principal vector of TBE in the region is *Ixodes ricinus*. This is a relatively small, three-host tick that primarily inhabits moist, dense forest biotopes, where mice and voles are abundant. *Ixodes hexagonus*, *I. trianguliceps*, *Dermacentor marginatus*, *D. reticulatus*, *Haemaphysalis concinna*, *H. punctata*, and *H. inermis* are secondary vectors, based on occasional isolations of TBE virus. *Ixodes persulcatus* may occur in a few, circumscribed areas of Central Europe. Since this species is easily mistaken for *I. ricinus*, its distribution in Central Europe is uncertain. In those areas where *I. persulcatus* occurs, it is a primary vector of TBE. Its life cycle is similar to that of *I. ricinus* and will not be further discussed. The bionomics of vector ticks in Central Europe is summarized in Appendix B. The known distribution of ticks in Central Europe is presented in Appendix A.3.

Ixodes ricinus occurs widely in upland forests (consisting primarily of oaks, hornbeams, or mixtures of these two groups) and, to a lesser degree, in lowland areas (consisting of beech, maple, alders and mixed shrubs). In southern parts of the region, this species occurs at higher altitudes (up to 1500 m) than in northern areas of Central Europe. This species also inhabits weedy pastures, hedgerows, and shady gardens. Populations of *I. ricinus* can persist for many years in areas that have been urbanized, especially in parks with populations of rodents, dogs and roe deer. It is not well adapted to desiccation and may die in a matter of weeks if humidity falls below 50 percent. However, where humidity is high, it can survive unfed for over two years. *Ixodes ricinus* feeds on a wide

range of hosts (it has been collected from over 150 species), although small terrestrial rodents (such as *Apodemus flavicollis* and *Clethrionomys glareolus*) are the most common hosts of immature ticks and are considered essential reservoirs for TBE virus. Female ticks lay 100 to 2,700 eggs, depending on the degree of engorgement. Eggs usually hatch in July and August. There are three active stages and each requires a bloodmeal in order for development to proceed. Larvae and nymphs usually require one to two years to complete development. Adults commonly feed on deer, foxes, rabbits, hedgehogs, squirrels, cattle, goats and, occasionally, humans. Large domestic animals, particularly sheep, are important in some areas in maintaining high populations of *I. ricinus*. Mating occurs before feeding or while the female is still feeding on the host. Females die after oviposition is completed. The complete life cycle normally requires three years in Central Europe. In marginal habitats the life cycle can last up to six years. All stages of this species, including eggs, can overwinter. Unmated females diapause during winter and become active in the spring. However, females that have mated during the summer do not diapause and exhibit peak activity in the autumn. Ticks are active primarily from April to October, although in southern areas they may be collected from March to December. Transovarial and transstadial transmission of TBE is extremely efficient in this tick.

Dermacentor marginatus is widely distributed in Central Europe and is found in a variety of habitats, including lowland forests, marshes and shrubby areas. This is a three-host tick. Larvae and nymphs feed on rodents, insectivores, hares or foxes, while adults feed on cattle, sheep, deer, other herbivores and, occasionally, humans. While larvae and nymphs are often active during the summer, adults frequently are inactive during this season, especially in northern areas. Larvae and nymphs are moderately resistant to desiccation and may live unfed for several months under dry conditions. Females that have diapaused over the winter begin laying eggs in the spring. Up to 2,500 eggs may be laid at this time. However, females that feed in late summer or early fall detach after seven days of feeding and lay up to 6,200 eggs. The entire life cycle is normally completed within one year. Occasionally, diapause may be spent on the host. Transstadial and transovarial transmission of TBE virus occurs in this species, although not as efficiently as in *I. ricinus*.

Dermacentor reticulatus (= *D. pictus*) has a wide distribution in Central Europe, including Croatia, Poland, Serbia and the Slovak Republic. It is found in mixed deciduous forests, meadows, and humid habitats along rivers, especially the Danube. Larvae feed on mice, voles and hedgehogs. Larvae are most abundant in June and July, while populations of nymphs peak in August and September. Adults feed on bear, sheep, cattle and dogs. This species overwinters primarily in the adult stage; consequently, adults are more abundant in the spring (April through May). The life cycle typically requires one year for completion. Development may be slower in forests than in meadows because of lower average temperatures in the forest environment. However,

survival rates are greater in forests than in meadows. Transstadial and transovarial transmission is efficient in this species. Up to 28% of infected female ticks pass TBE virus to their progeny.

Haemaphysalis concinna is a small tick that inhabits meadows alternating with birch-aspen clearings, areas of sparse shrubs along rivers and streams, and marshy areas overgrown with sage or ferns. Adult females engorge for three to nine days on cattle, sheep, goats and deer. They begin laying eggs 14 to 66 days after detaching from their hosts. Larvae emerge 39 to 114 days after oviposition. Immature ticks feed on hares, hedgehogs and rodents. Larvae engorge for two to four days, drop off the host, and molt into nymphs 34 to 86 days after engorgement. Adults emerge from engorged nymphs 23 to 111 days after nymphs detach. Larval and nymphal stages are more abundant in late summer and autumn. Nymphs that emerge late in the year may go into diapause and molt to adults the following spring; consequently, adults are more common between April and June. Active adults can be collected through the summer and into October. In most cases the life cycle can be completed in one year, although development may require up to three years. Transstadial and transovarial transmission of TBE virus occurs, but not as efficiently as in *I. ricinus*.

Haemaphysalis inermis is a three-host tick that is sparsely distributed in Central Europe. Larvae feed on shrews, hedgehogs and small rodents. Larval ticks feed only a few hours before detaching from their hosts. The adult stage is large and may reach up to 10 to 12 mm in length. Adults feed on deer, cattle, foxes and goats. Adults take large blood meals over several days but produce only about 200 large eggs. TBE virus is transstadially passed in this tick, and transovarial transmission probably occurs as well.

Haemaphysalis punctata occurs widely, but very focally, in submediterranean biotopes. This tick is moderately resistant to aridity and inhabits shrubby growth, forests or pastures. It is most abundant in areas of pubescent oak and dwarf shrub heath. This species has been reported in Bulgaria, the Slovak Republic, Greece and Serbia, and probably occurs in other countries of Central Europe. *Haemaphysalis punctata* is also a three-host tick. Immature stages quest passively in grassy areas and feed on birds, voles and hares. Larvae are most abundant in July and August, while nymphs are more abundant from July to October. Adults feed on the same range of hosts as *D. marginatus* (sheep, cattle, dogs, goats, deer, and humans), often attaching in the groin or neck area. This tick is frequently found in association with *D. marginatus* and *D. reticulatus*. Adults overwinter, become active in March and April, and begin oviposition in May and June. However, immature stages may also overwinter. Transovarial transmission of TBE virus is believed to occur but has not been conclusively demonstrated.

Ixodes hexagonus is a relatively large species, sometimes reaching dimensions of 1.1 by 0.7 cm when engorged. This three-host tick inhabits lowland and hilly areas below

1,000 m. It frequently occurs in caves, dens and pits, where its hosts normally are found. Both larval and nymphal stages feed for three to seven days. All stages commonly infest hedgehogs, foxes, martens, wolves, wild cats and dogs. Occasionally, this species infests badgers, domestic cats and cattle. *Ixodes hexagonus* is a very important zoonotic vector, but humans are reportedly not attacked. Females mate, complete engorgement, and begin laying eggs within two weeks of fertilization. Eggs hatch in about four weeks, and the entire life cycle may take as little as four months in Slovenia but is generally much longer in cooler climates, requiring at least one full year. Transstadial transmission of TBE has been demonstrated in this species.

Ixodes trianguliceps is a common tick in grassy hills and forested mountains along the Adriatic coast and in Serbia between 500 and 2000 m. It also occurs at lower densities in Bulgaria, the Slovak Republic and, probably, adjacent countries. It is very resistant to cold temperatures. In all stages, this three-host tick feeds mainly on small mammals, such as *Apodemus* spp., moles, voles and shrews. It does not feed on humans and is considered a zoonotic vector of TBE virus. Larvae occur from February to December, with a peak of activity in October. Nymphs and adults occur sequentially from April through October. Development can take place within a one-year period, although in colder regions it is likely to take longer.

Vector Surveillance and Suppression. Surveillance techniques for ixodid ticks are discussed in TIM 26, Tick-Borne Diseases: Vector Surveillance and Control, and under Lyme disease. Control of *I. ricinus* over large areas with acaricides is impractical and environmentally unacceptable. In areas where viral transmission is endemic, **personal protective measures** must be used. Regular inspection to remove ticks should be performed as often as practical. Military personnel should not consume local dairy products.

A formalin-inactivated cell culture vaccine has been widely used in European countries for many years with few side effects. A full course of vaccination includes three primary doses, with a booster six to 12 months later. Vaccine efficacy approaches 97%; however, the FDA has not approved a vaccine for TBE. The vaccine can be administered to U.S. personnel only under an investigational new drug (IND) protocol. To protect US military forces deployed to Bosnia in early 1996 as part of Operation Joint Endeavor, an inactivated, parenteral vaccine produced in Austria was offered on a volunteer basis to soldiers at high risk of exposure to TBE.

H. Crimean-Congo Hemorrhagic Fever.

Crimean-Congo Hemorrhagic Fever (CCHF) is a zoonotic disease caused by a tick-borne virus of the family Bunyaviridae. The disease is characterized by febrile illness with headache, muscle pain and rash, frequently followed by a hemorrhagic state with hepatitis. The mortality rate can exceed 30%. The incubation period ranges from three

to 10 days. CCHF may be clinically confused with other hemorrhagic infectious diseases.

Military Impact and Historical Perspective. Descriptions of a disease compatible with CCHF can be traced back to antiquity in eastern Europe and Asia. CCHF was first described in soldiers and peasants bitten by ticks of the genus *Hyalomma* while working and sleeping outdoors on the Crimean peninsula in 1944. The virus was first isolated in 1967. Since there are no available treatment regimens of proven value and recovery from CCHF can be protracted, military personnel with CCHF would require significant medical resources.

Disease Distribution. CCHF virus has the widest geographic distribution of any tick-borne virus. It is enzootic in the steppe, savanna, semi-desert and foothill environments of eastern and central Europe, Russia, parts of Asia, and throughout Africa. These are favored habitats of xerophilous *Hyalomma* ticks. In the deciduous forests of Moldavia, *Ixodes ricinus*, *Dermacentor* and *Rhipicephalus* species have replaced hyalommine species due to changing practices of handling cattle herds.

Several Eurasian CCHF epidemics have taken a great toll of human life. In recent years, cases of CCHF have tended to be sporadic, with most reported from Bulgaria and South Africa. Bulgaria recorded 1410 cases, primarily in agricultural workers, between 1953 and 1992. However, CCHF is underdiagnosed in many countries due to lack of appropriate medical and laboratory services. CCHF virus is likely enzootic in widely distributed discrete foci in agricultural areas throughout Central Europe. Vector ticks are common on domestic animals throughout the region. Movement of domestic animals between countries in the region is common and can easily spread the disease. The prevalence of human antibodies to CCHF virus in most rural areas of Central Europe ranges from 0.1 to 3%, although studies conducted in the mid-1980s revealed that up to 12% of inhabitants were seropositive in some enzootic areas of the former Republic of Yugoslavia. An outbreak affecting 55 people occurred in the Kosovo and Montenegro areas of Serbia in 1995. The risk of transmission is highest from April through September.

Transmission Cycle(s). CCHF virus has been isolated from at least 30 species of ticks. From experimental evidence, it appears that many tick species are capable of transmitting the virus, but members of the genus *Hyalomma* are the most efficient vectors. The aggressive host-seeking behavior of adult hyalommine ticks makes them ideal vectors. The highest prevalence of antibodies in wild and domestic reservoirs has been found in many areas where *Hyalomma* ticks are common. Antibodies to CCHF virus are widespread in hares and large wild and domestic herbivores in Central Europe. Domestic ruminants generally acquire infection early in life. Viremia in livestock is short-lived and of low intensity. Antibodies or virus have also been found in a variety of small

mammals, including hedgehogs and rodents. Infected wild and domestic animals show no serious signs of disease. Transovarial transmission of virus in vector ticks is an important reservoir mechanism. The wide range of tick species from which CCHF virus has been isolated, the diversity of life cycles and habitats of these ticks, and the uncertain involvement of various vertebrates have contributed to a poor understanding of the complex transmission and maintenance cycles of CCHF.

Persons occupationally exposed to domestic animals, such as animal husbandry and abattoir workers, have the greatest risk of infection. Humans acquire CCHF virus from tick bites, from contamination of broken skin or mucous membranes with crushed tissues or feces of infected ticks, or from contact with blood or other tissues of infected animals. CCHF virus is highly infectious, and nosocomial infection of medical workers has been important in many outbreaks.

CCHF virus loses infectivity shortly after the death of an infected host. There is no indication that consumption of meat processed according to normal health regulations constitutes a hazard.

Vector Ecology Profiles.

Hyalomma marginatum marginatum is the principal vector in Bulgaria, Albania and the former Yugoslavia. Other vector species that act as secondary or enzootic vectors include *Boophilus annulatus*, *Dermacentor marginatus*, *Haemaphysalis punctata*, *Ixodes ricinus*, and *Rhipicephalus bursa*.

Hyalomma m. marginatum inhabits upland woods and meadows in the Sredna Gora hills, Bulgaria, at altitudes of 340 to 550 m. In Bulgaria, this two-host tick primarily attacks horses and cattle. It begins feeding on cattle in March, and tick populations increase through July but then decline precipitously. This species also inhabits cattle-ranching areas of the former Yugoslav republics, with rolling, hilly terrain from 600 to 800 m. This is one of the hardiest, most cold-resistant ticks in the world and can survive arid conditions as well. Immature stages quest actively from rodent burrows or grasses and feed primarily on small mammals (rodents, hedgehogs and hares) and birds (chiefly rooks and magpies). Nymphs feed from five to eight days before dropping off their hosts. After molting, adult ticks await their next host by questing from tall grasses, often in pastures. In addition to cattle and horses, adults feed on goats, dogs, sheep and, occasionally, humans. After feeding for 4 to 6 days, adult females drop off their hosts and oviposit several thousand eggs. Under ideal conditions, the life cycle can be completed in a single year, although adults often overwinter and begin laying eggs in the spring. Under adverse conditions, the life cycle can be extended for two or more years. Transovarial and transstadial transmission of CCHF virus occur in this species, although migratory birds are believed to re-introduce infected ticks each year throughout the region.

Boophilus annulatus is a one-host tick that feeds primarily on cattle and only occasionally feeds on deer, horses and man. After feeding and mating on the host, females drop to the ground and rest for up to a month before laying eggs. The female dies after depositing 2,000 to 4,000 eggs over an eight to nine day period. The life cycle typically requires less than one year but may be prolonged under adverse conditions. Under favorable conditions, larvae hatch after three to seven weeks and actively quest for new hosts from the tips of grasses, often in pastures. This species is considered a marginal, enzootic vector of CCHF virus.

Dermacentor marginatus has been reported as a vector in Bulgaria and Moldavia in Romania. *Ixodes ricinus* has been reported as a vector in Bulgaria, the former Yugoslav republics and Moldavia, Romania. Transstadial and transovarial transmission are known to occur in this species. *Rhipicephalus bursa* has been reported as a vector in Bulgaria and Greece. *Boophilus annulatus* and *R. sanguineus* have been reported as vectors in Bulgaria. *Haemaphysalis punctata* has been reported as a vector in Bulgaria and Moldavia, Romania.

The vector ecologies of *D. marginatus*, *I. ricinus*, and *H. punctata* are described under tick-borne encephalitis. The vector ecology of *R. bursa* can be found under Lyme disease. Information on these and other tick vectors is summarized in Appendix B. Appendix A.3 lists the distribution of ticks in Central Europe.

Vector Surveillance and Suppression. Military personnel should conscientiously use **personal protective measures** to prevent tick bites (see TIM 36). Frequent self-examination and removal of ticks are important. Ticks should be handled as little as possible and not crushed. Troops should not sleep, rest or work near rodent burrows, huts, abandoned rural homes, and livestock or livestock enclosures. Close contact with livestock and exposure to locally butchered animals should be avoided.

An inactivated mouse-brain vaccine against CCHF has been used in eastern Europe and the former Soviet Union. The FDA has not approved a vaccine for human use. A purified modern vaccine will probably not be developed in view of the limited potential demand.

I. Boutonneuse Fever. (Mediterranean tick fever, Mediterranean spotted fever, Marseilles fever, African tick typhus, Kenya tick typhus, India tick typhus) This tick-borne typhus is a mild to severe illness lasting a few days to two weeks. Clinical symptoms begin 6 to 10 days after the bite of an infected tick and include fever, headache and muscle pain. Boutonneuse fever is caused by *Rickettsia conorii* and closely related rickettsial organisms. Different strains of *R. conorii* isolated from ticks and humans indicate that this pathogen has substantial genetic and antigenic diversity. *Rickettsia slovaca* is a related pathogen found in Central Europe that causes the same

clinical disease. The common name of this disease comes from the button-like lesions, two to five mm in diameter, that develop at tick attachment sites. With antibiotic treatment, fever lasts no more than two days. The case fatality rate is usually very low, even without treatment.

Military Impact and Historical Perspective. Historically, boutonneuse fever has not significantly interfered with military operations. Sporadic cases among combat troops can be expected in limited geographic areas. The severity of illness will be dependent upon the strain of *R. conorii* contracted. Because the spotted fevers are regional diseases, military medical personnel newly assigned to an area may be unfamiliar with them and diagnosis may be delayed.

Disease Distribution. Boutonneuse fever is widespread in countries bordering the Mediterranean, and most countries of Africa. Along the European Mediterranean coast, the seroprevalence of boutonneuse fever varies from 4.2 to 45.3%, depending on the geographical region. Expansion of the European endemic zone to the north is occurring because North European tourists vacation along the Mediterranean with their dogs, which acquire infected ticks and are then brought home.

Boutonneuse fever is focally enzootic throughout Central Europe but is more prevalent along coastal areas. *Rickettsia conorii* appears to be the more common and widespread pathogen, particularly in coastal areas of the region, while *R. slovaca* is more common in inland areas, especially Hungary, the Slovak Republic and the Czech Republic. The incidence of boutonneuse fever appears to be increasing in the Mediterranean basin, including the Adriatic coast of Croatia. Studies in the early 1990s found that antibodies to *R. conorii* were present in 5% of the inhabitants living in coastal areas of Dalmatia, and in 62.4% of the dogs surveyed from southern coastal Croatia. A significantly higher seroprevalence (69.9%) was found in dogs from suburban or semirural areas than in dogs from urban areas of Croatia (20.7%). A 1996 study of rodents collected from localities in southwestern and south-central Slovenia found a seroprevalence of 70 to 90% in the house mouse, *Mus musculus*, and the field mouse, *Apodemus agrarius*. The disease is enzootic in the Black Sea coastal areas of Bulgaria and Romania and the coastal regions of Serbia and Greece. However, a seroprevalence of over 40% was found among inhabitants of rural villages in central Greece during 1991. Few medical reports are available for Albania.

Transmission cycle(s). The disease is maintained in nature by transovarial passage of rickettsiae in ticks, primarily the brown dog tick, *R. sanguineus*, although almost any ixodid tick may harbor the pathogen. Enzootic infection in dogs, rodents, hares and other animals is usually subclinical. Transmission to humans is by bite of infected ticks. Contamination of breaks in the skin, mucous membranes, or eyes with crushed tissues or

feces of infected ticks can also lead to infection. Close association with domestic dogs in endemic areas is a risk factor for boutonneuse fever.

Vector Ecology Profiles.

Rhipicephalus sanguineus, the brown dog tick, is the primary vector, as well as reservoir, of *R. conorii*. This species is widespread throughout the region, probably occurring in every country. Probable zoonotic vectors include *Ixodes hexagonus* and the flea *Archeopsylla erinacei*. These zoonotic vectors frequently feed on hedgehogs and rabbits. All stages of ticks, including eggs, can be infected with rickettsiae, indicating that transmission occurs both transstadially and transovarially. The primary vectors of *R. slovaca* include *Dermacentor marginatus*, *Ixodes ricinus*, and *Haemaphysalis punctata*, the larvae and nymphs of which infest small rodents. Possible secondary vectors include *Dermacentor reticulatus* and *Haemaphysalis inermis*. Vector ecology profiles of *D. marginatus*, *D. reticulatus*, *H. inermis*, *H. punctata*, and *I. ricinus* are presented under the section on tick-borne encephalitis. Appendix A.3 lists the known distribution of ticks in Central Europe.

Rhipicephalus sanguineus is a three-host tick, with larval, nymphal and adult stages preferring to feed primarily on dogs and occasionally on humans. Larvae and nymphs of *R. sanguineus* spend three to six days feeding on hosts, then drop off to molt. Males feed on hosts for three to five days but do not produce sperm until after engorgement. After mating on the host animal, the female feeds for seven to 15 days, then drops off the host to lay eggs. Females of this species lay hundreds of eggs, generally in the dens of host animals, particularly canines. Eggs may require 10 to 20 days to hatch. Adult *R. sanguineus* are passive in their host-questing activity, rarely moving more than two meters to find a host. This species requires a humid microhabitat, which can be found in the dens of its hosts even if the area is arid. The entire life cycle may require up to two years to complete, although one year is usually sufficient. Larval and nymphal stages may survive months without a host.

Archeopsylla erinacei is the only flea that is involved in the zoonotic cycle of this group of diseases. This species has been reported from the Czech Republic, the Slovak Republic and Greece, although it undoubtedly occurs in adjacent countries as well. *Archeopsylla erinacei* normally parasitizes hedgehogs, foxes, dogs, martens and polecats, and only occasionally bites humans. Eggs are laid in the nesting material or dens of the hosts. Newly hatched larvae feed on dried blood, feces, dander and other organic debris occurring in the nest. The duration and number of larval stages can be highly variable, depending on temperature. Pupation occurs in the same den or nesting area inhabited by larvae. Adults emerge a short time later (usually several days), depending on temperature and the presence of hosts. The entire life cycle may be completed in a matter of weeks under favorable conditions.

Vector Surveillance and Suppression. Personal protective measures (see TIM 36) afford the best protection against boutonneuse fever. In endemic areas domestic dogs are commonly infested with the brown dog tick. Troops should not be allowed to feed, befriend or adopt local dogs as pets.

J. Rickettsialpox. (Vesicular rickettiosis)

Rickettsialpox is an acute febrile illness transmitted by mites. The disease is caused by *Rickettsia akari*, a member of the spotted fever group of rickettsiae. The mite bite is painless and a skin lesion or eschar develops at the bite site within 24 to 48 hours. There is a seven to 12 day incubation period followed by fever, malaise, headache and muscle pain. A vesicular rash of 20 to 100 papules (two to 10 mm in diameter) appears on the face, trunk and extremities. The palms and soles are not affected. The rash disappears in a few days without scarring. Untreated cases recover seven to 10 days after onset of symptoms, and death is rare. Human to human transmission does not occur.

Military Impact and Historical Perspective. The disease was recognized in New York City in 1946, but outbreaks have been reported from Russia, Ukraine, South Korea, South Africa and equatorial Africa. Rickettsialpox is typically a mild disease that is easily treated with antibiotics. Most infections have occurred in crowded urban areas with large rodent populations. It is unlikely to affect military operations, but epidemics in civilian or refugee populations are likely when living standards are degraded by war. The disease may be clinically confused with chickenpox or spotted fever.

Disease Distribution. *Rickettsia akari* was isolated in Croatia in 1991. This was the first report of rickettsialpox in Central Europe in 40 years. The disease has the potential to spread and remain endemic in populations living under crowded, unsanitary conditions in parts of the former Republic of Yugoslavia destroyed by civil war.

Transmission cycle(s). Infection with *R. akari* is spread through the bite of the house-mouse mite, *Liponyssoides sanguineus* (formerly called *Allodermanyssus sanguineus*). Experimental transmission of *R. akari* by the tropical rat mite, *Ornithonyssus bacoti*, has been demonstrated, and this species may act as a secondary vector. Transovarial passage of rickettsiae occurs, implicating the vector as a reservoir.

Vector Ecology Profile. Although the house mouse, *Mus musculus*, is the preferred host, *L. sanguineus* has been collected from other commensal rodents and small wild mammals, including the Korean vole, *Microtus fortis*, and jirds, *Meriones* spp. The mite is a nest-dweller and leaves the host after feeding. Larvae do not feed, so transmission is by feeding nymphs and adults of both sexes. Mites can be found in nesting materials, or crawling along rodent runways, or on the ceilings and walls of heavily infested buildings. Development from egg to adult requires two to three weeks. Unfed females have been observed to live up to 50 days.

Vector Surveillance and Suppression. Humans appear to be accidental hosts and are more likely to be attacked when murine hosts are scarce or suddenly reduced by rodent control programs. Disease outbreaks are prevented or controlled by rodent elimination in conjunction with mite control. Nesting materials should be destroyed and rodent harborages treated with a residual insecticide. Mites can be collected from debris and nesting material with a Berlese funnel.

K. Q Fever. (Query fever)

This is an acute, self-limiting, febrile rickettsial disease caused by *Coxiella burnetii*. Onset may be sudden with chills, headache and weakness. Pneumonia is the most serious complication. There is considerable variation in severity and duration of illness. Infections may be inapparent or present as a nonspecific fever of unknown origin. Acute Q fever is self-limited and the case fatality rate in untreated acute cases is usually less than 1%. Chronic Q fever is a serious and often fatal illness with high mortality rates. Illness occurs months to years after the acute infection, and endocarditis occurs in up to 10% of patients.

Military Impact and Historical Perspective. *Coxiella burnetii* was originally described from Australia in 1937. In ensuing years, *C. burnetii* was found to have a worldwide distribution and a complex ecology and epidemiology. Q fever first appeared among Allied troops in 1944 and 1945, when several sharp outbreaks occurred in the Mediterranean Theater. The disease was not recognized immediately because this rickettsial pathogen had been reported as occurring naturally in humans only in Queensland, Australia. The need to consider Q fever in the differential diagnosis of primary atypical pneumonia was recognized during this period, but it took several years for this knowledge to become widespread in field military medicine. The British Army in the Mediterranean area experienced several localized epidemics of atypical pneumonia characterized by a high attack rate, up to 50% of some units. This was probably Q fever, but no serological proof was ever obtained. Three cases of Q fever were recorded in US military personnel during the Persian Gulf War.

Disease Distribution. *Coxiella burnetii* has been reported from at least 51 countries. Incidence is greater than reported because of the mildness of many cases. Q fever is enzootic throughout Central Europe, with most countries reporting sporadic isolated cases and occasional epidemics. The disease is highly enzootic in western Poland. In 1988 an epidemic was detected in the Leszno district, and 34% of 4,264 animal workers tested positive for *C. burnetii* antibodies. On one farm, 32% of the cattle were seropositive, as were 68% of workers in direct contact with infected animals and 29% of persons drinking raw milk. *Coxiella burnetii* was isolated from ticks, wild mammals and birds in close proximity to the farm. From 1992 to 1994, three additional outbreaks occurred in different regions of Poland.

From 1982 to 1985, 725 cases of Q fever were reported near the town of Knezha, Bulgaria. Romania recorded 134 sporadic cases of Q fever from 1981 to 1987. Seroprevalence to *C. burnetii* in the early 1990s varied from 1.1% of blood donors in Strakonice and Novy Jicin districts of the Czech Republic to 19% of blood donors in northwestern Croatia. Over 10% of sheep in enzootic areas of Slovenia were seropositive in 1996.

The epidemiology of Q fever has changed in many Central European countries as a result of dramatic political and economic shifts in the early 1990s. In Bulgaria, the large state cooperative farms collapsed and the number of cattle and sheep decreased. Individuals began raising goats, and the consumption of raw goat milk and its products increased. Goats thus replaced cattle and sheep as the main source of human *C. burnetii* infections. Hundreds of cases of Q fever were reported from Bulgaria during the 1990s, including chronic forms of Q fever with endocarditis. Goats are a threat to human health in every Central European country where they are raised extensively.

Since the 1980s, only sporadic cases of Q fever have been reported from different parts of Slovakia. Better preventive measures, including control of animal movement, veterinary surveillance, and vaccination of domestic animals, have prevented Q fever from being a serious public health problem. Recent studies indicate that the strains of *C. burnetii* circulating among cattle in the Czech Republic and the Slovak Republic have a low virulence in humans.

Vector Ecology Profiles. Several species of ixodid ticks transmit *C. burnetii* to animals but are not an important source of human infection. *Coxiella burnetii* has been isolated from *Ixodes ricinus*, *Dermacentor reticulatus*, *D. marginatus*, *Haemaphysalis concinna*, *H. punctata* and *H. inermis* in enzootic areas of Central Europe.

Transmission Cycle(s). In nature there are two cycles of infection with *C. burnetii*. One involves arthropods, especially ticks, and a variety of wild vertebrates. The most important reservoirs are small wild rodents, but infection has also been demonstrated in insectivores, lagomorphs, carnivores, ungulates, marsupials, monkeys, bats, birds and even reptiles. The other cycle is maintained among domestic animals. Although humans are rarely if ever infected by ticks, arthropods may transmit infection to domestic animals, especially sheep and cattle. Domestic animals have inapparent infections but shed large quantities of infectious organisms in their urine, milk, feces, and especially their placental products. Because *C. burnetii* is highly resistant to desiccation, light and extremes of temperature, infectious organisms become aerosolized, causing widespread outbreaks in humans and other animals, often at a great distance from the place of origin. Dust in sheep or cattle sheds may become heavily contaminated. Once established, animal-to-animal spread of *C. burnetii* is maintained primarily through airborne transmission. Outbreaks of Q fever in humans have been traced to consumption of

infected dairy products and contact with contaminated wool or hides, infected straw, and infected animal feces. *Coxiella burnetii* may enter through minor abrasions of the skin or the mucous membranes. Although rare, human-to-human transmission of Q fever has occurred.

Vector Surveillance and Suppression. A satisfactory vaccine has not been developed, and human vaccination has been hampered by the high rate of adverse reactions. Measures to identify and decontaminate infected areas and to vaccinate domestic animals are difficult, expensive and impractical. Military personnel should avoid consumption of local dairy products and contact with domestic animals, hides, or carcasses. During the Persian Gulf War, troops were frequently exposed to domestic animals and carrion. Soldiers should not rest, sleep, or work in animal sheds or other areas where livestock have been housed.

L. Tularemia. (rabbit fever, deer fly fever, Ohara disease, Francis disease)
Tularemia is caused by the bacterium *Francisella* (formerly *Pasteurella*) *tularensis*. Two biovars with differing pathogenicity cause human disease. Jellison type A, or *F. tularensis* biovar *tularensis*, is more virulent. It can produce an untreated case-fatality rate of five to 15% from pulmonary disease or symptoms similar to typhoid. Jellison type B, or *F. tularensis* biovar *palaeartica*, is less virulent, and even without treatment produces few fatalities. Tularemia may be clinically confused with typhoid fever, plague and other infectious diseases.

Clinical manifestations vary according to the route of infection and the pathogenicity of the bacterial strain. Usually infection produces an ulcer or papule at the site of inoculation, with swelling of the regional lymph nodes. Early symptoms include fever, headache, abdominal pain, cough and vomiting. Ingestion of organisms in contaminated food or water may produce a painful pharyngitis, vomiting and diarrhea. Inhalation of infectious material may be followed by severe pulmonary disease. Tularemia is easily treated with antibiotics. Long-term immunity follows recovery, though reinfection has been reported.

Military Impact and Historical Perspective. The impact of tularemia on military operations would be minimal. Sporadic cases should be expected, but tularemia can be epidemic when water or food supplies are contaminated.

Disease Distribution. Tularemia is focally distributed throughout Central Europe. From 1985 to 1994, 126 cases of tularemia were reported from western Slovakia, which has been an endemic area for several decades. In April 2000, 231 confirmed cases of tularemia occurred in Kosovo, with most cases in the western area. The majority of cases occur during the summer, primarily in occupationally exposed persons like foresters. In Central Europe, tularemia has historically been caused by strains of *F. tularensis* that

produce clinically mild disease. The first isolations of *F. tularensis* biovar *tularensis* in Europe were reported from Slovakia in 1998. These findings significantly increased the public health importance of tularemia in the region.

Transmission Cycles. The epidemiology of tularemia varies markedly in different geographic regions. *Francisella tularensis* has been isolated from over 100 kinds of wildlife and domestic animals and from the natural waters frequented by reservoir hosts such as the water vole, *Arvicola terrestris*, and muskrats. Infection among rodent species varies from asymptomatic disease to rapid death of an entire colony. The European brown hare, *Lepus europaeus*, is a very good indicator of the presence of tularemia and has been used routinely for the surveillance of this zoonosis in Central Europe.

The primary mode of transmission in the region is by direct contact of the skin or conjunctivae with infected blood or tissues from hares and rodents. Other important routes of infection include ingestion of contaminated food or water and inhalation of soil, grain, hay or other agricultural products contaminated with the excreta of infected animals. Rabbit meat frozen at -15°C has remained infective more than three years.

Francisella tularensis has been isolated from at least 60 species of ticks, mites, fleas, deer flies and mosquitoes. Transovarial and transstadial transmission have been demonstrated in ixodid ticks. Although tick-borne transmission is common in North America, tick-borne cases have historically been infrequent in Central Europe. However, recent studies in Slovakia indicate that tick-borne transmission of tularemia is rapidly becoming more common. Other methods of acquiring the disease include direct inoculation into the skin from an infected animal bite or scratch. A high percentage of farm dogs and free-ranging dogs in Slovakia have been infected with *F. tularensis*. Laboratory infections are common. Under normal circumstances, person-to-person transmission does not occur, although congenital infection has been reported.

Vector Ecology Profiles.

Early isolates of the pathogen, *Francisella tularensis*, were made from *Dermacentor reticulatus* and *Ixodes ricinus* in the Czech Republic and Croatia. These ticks transmit the disease to hares, which are the primary zoonotic hosts of the disease. Other hosts for these ticks and the pathogen include several species of field mice and voles. Strains of *Francisella tularensis* have also been isolated from *Dermacentor marginatus* and *Ixodes trianguliceps* in the Czech Republic and from *Haemaphysalis concinna* collected in the western part of Slovakia. The bionomics and distribution of these vector species are discussed under tick-borne encephalitis and summarized in Appendix B. The known distribution of ticks in Central Europe appears in Appendix A.3.

Vector Surveillance and Suppression. Area vector control is not necessary. The permethrin-impregnated uniform is very effective against crawling arthropods like ticks.

Military personnel should not handle rodents and should avoid rodent secretions. Wild rabbits and hares should not be hunted for food. Natural foci of the disease appear to be stable and are unlikely to be eradicated. Live attenuated vaccines have been used extensively in the former Soviet Union and to a limited extent in the US for occupational risk groups, such as laboratory workers. Chemoprophylaxis is not recommended.

M. Relapsing Fever (tick-borne). (Endemic relapsing fever, cave fever)

This is a systemic spirochetal disease characterized by periods of fever alternating with afebrile periods. The number of relapses varies from one to 10 or more. The severity of illness decreases with each relapse. The duration of tick-borne relapsing fever is usually longer than the closely related louse-borne relapsing fever. A number of species of *Borrelia* are responsible for the disease. The taxonomy of the pathogen is complex. The close vector-spirochete relationship has led to the definition of most spirochete species by their tick vectors. There is great strain variation among tick-borne *Borrelia*, and a single strain can give rise to many serotypes.

Military Impact and Historical Perspective. Although clinical symptoms of tick-borne relapsing fever can be severe, impact on military personnel would be minimal due to low incidence of the disease.

Disease Distribution. Tick-borne relapsing fever is focally enzootic throughout Central Europe, but only sporadic human cases are reported. Transmission is most likely to occur from April through November. Vector ticks commonly infest caves, bunkers and tombs.

Transmission Cycle(s). Argasid (soft) ticks of the genus *Ornithodoros* transmit tick-borne relapsing fever. Infection is transmitted from human to human, animal to animal, or from animal to human by the bite of infective ticks. Rodents are sources of infection for ticks, although ticks are more important as a long-term reservoir. In some tick species, the pathogen has been maintained naturally for years by transovarial transmission. The rate of transovarial transmission varies greatly among tick species. Ticks of both sexes and all active stages transmit the pathogen by bite or by infectious fluids exuded from pores in the basal leg segments. Spirochetes can pass into bite wounds or penetrate unbroken skin. Exposure to infected blood of patients can cause infections in medical personnel.

Vector Ecology Profiles.

Ornithodoros spp. ticks are the vectors of tick-borne relapsing fever in Central Europe. In addition to their role in the transmission of relapsing fever, this genus is important because it includes several species that inflict painful bites, some of which can produce local or systemic reactions in humans.

Most *Ornithodoros* ticks inhabit restricted habitats, such as rock outcroppings, caves, dens, burrows, nests and other sheltered habitats. Some species are parasitic on livestock and are found in stables and places where host animals rest. Adult *Ornithodoros* spp. feed at night, usually for only one to two hours. Males are slightly smaller than females but similar in appearance. Larvae may remain attached to their hosts for protracted periods of several days. Subsequent nymphal stages are active and require blood meals in order to develop. Engorgement is rapid, and nymphs drop off their hosts after feeding for brief periods. Nymphs and adults of some species feed quickly and painlessly, so their bites may go undetected by the human host until well after the tick has detached. After a variable number of molts (generally four to five), adults emerge and mate. In contrast to ixodid (hard) ticks, female *Ornithodoros* do not die after oviposition. Females may live many years without a bloodmeal, but blood is required for egg development. Over the life span of the female, the number of eggs deposited may total several hundred, with up to eight batches of eggs produced. A list of tick species and their distribution appears in Appendix A.3.

Vector Surveillance and Suppression. Argasid ticks like *Ornithodoros* are found in the restricted habitats of their hosts and rarely move very far. They occupy loose, dried soil of dwellings, cracks and crevices in mud-walled animal shelters, animal burrows and resting places, and the undersides of tree bark. They can be collected by passing soil through a metal sieve or by blowing a flushing agent into cracks and crevices and other hiding places. Some species are attracted by carbon dioxide, and dry ice can be used in the collection of burrow-dwelling ticks. *Ornithodoros* ticks also fluoresce under ultraviolet light. There is little seasonal fluctuation in numbers of argasids since their microhabitats are relatively stable. **Personal protective measures** (see TIM 36) are the most important means of preventing bites and diseases transmitted by soft ticks. Tents and bedding can be treated with the repellent permethrin. Encampments should not be established in areas infested with *Ornithodoros* ticks. Troops should avoid using indigenous shelters, caves, or old bunkers for bivouac sites or recreational purposes. Control of small mammals around cantonments can eliminate potential vector hosts. Rodent-proofing structures to prevent colonization by rodents and their ectoparasites is an important preventive measure. Limited area application of appropriate acaricides, especially in rodent burrows, can reduce soft tick populations. Medical personnel may elect to administer antibiotic chemoprophylaxis after exposure to tick bites when risk of acquiring infection is high. See Appendix F for personal protective measures.

N. Bhanja Virus.

Bhanja viral infection is a tick-borne disease appearing as a simple febrile illness or with symptoms of meningitis. This pathogen is an unclassified virus in the family Bunyaviridae.

Military Impact and Historical Perspective. Bhanja virus was first isolated in 1954 from *Haemaphysalis* ticks collected on goats in India. It is unlikely to have a significant military impact due to the high percentage of asymptomatic infections and the mild nature of the clinical disease. Over 60% of the residents of some villages of Brac Island, off the Adriatic coast of Croatia, have antibodies to Bhanja virus, but no outbreaks of febrile illness in the human population of Brac have been recorded.

Disease Distribution. Bhanja virus has been isolated from at least 15 countries of Asia, Africa and Europe, and serological evidence indicates it may be present in at least 15 additional countries. Natural foci of the virus occur in the steppe or forest-steppe zones of Central Asia and Europe. Bhanja virus has been isolated from Croatia's Brac Island, Bulgaria, the Czech and Slovak Republics, Romania, Serbia, and along the border between Slovenia and Italy. Serological evidence indicates that the virus is also circulating in other Central European countries. Over 90% of some goat and sheep herds in Slovakia and Bulgaria have tested positive for antibodies to Bhanja virus. Serological surveys indicate that the highest endemicity is along the Adriatic coast.

Transmission cycles. Isolation of Bhanja virus from mammals is rare. Antibodies to Bhanja virus are common in domestic animals and have occasionally been found in rodents and birds. A characteristic feature common to all natural foci of the virus is intense pasturage of cattle, sheep or goats and abundant ticks of the genera *Dermacentor* and *Haemaphysalis*. Serological evidence indicates that sheep play a major role in the maintenance of the virus in Central Europe.

In Central Europe, Bhanja virus has been isolated most often from *Dermacentor marginatus* and *Haemaphysalis punctata*. The virus has also been isolated from *Haemaphysalis sulcata* in Bulgaria and an unidentified *Dermacentor* species in Romania. The immature stages of these species may acquire their infections from small mammals; adult ticks then transmit the virus to domestic animals.

Haemaphysalis sulcata inhabits submediterranean biotopes (both mountainous and high plateau terrain) that encompass semi-arid or scrubby areas. At lower elevations this species has been collected in vegetation ranging from thermophilic oak forests to beech and pines. It has been reported from Greece, Croatia, Bulgaria and Serbia, and probably occurs in adjacent countries. It is a small tick that feeds on hares, rodents and even small lizards in its immature stages. The adult stage feeds primarily on goats, sheep and deer. Adults are abundant in fall and winter and are active the following February and March. They feed on their hosts for 10 to 13 days before dropping off to lay eggs. Larvae hatch in the spring and feed for three to 17 days before dropping off the host and molting into nymphs, which are most abundant from June through August. Adults emerge from engorged nymphs in the autumn. Larvae and nymphs that emerge too late in the autumn to find a host may enter diapause and molt into adults the following spring. All stages

can overwinter, although most often it is the adult stage that does so. The entire life cycle is usually completed in one year. Vector ecology profiles for *H. punctata* and *D. marginatus* appear under tick-borne encephalitis.

Vector Surveillance and Suppression. Personal protective measures (see TIM 36) afford the best protection against the ticks that transmit Bhanja virus. Military personnel should be especially vigilant in areas used to graze or hold sheep and goats.

O. Ehrlichiosis.

Until the 1980s, *Ehrlichia* spp. were known primarily as pathogens transmitted by ixodid ticks to dogs, cattle, sheep and goats. The first well-substantiated report of a human infection with *Ehrlichia* in the U.S. appeared in 1986. Since that original case report, 1,223 human cases of ehrlichiosis have been reported in the U.S. through 1997. There are two distinct forms of human ehrlichiosis: human monocytic ehrlichiosis (HME) caused by *E. chaffeensis* that infects mononuclear phagocytes, and human granulocytic ehrlichiosis (HGE) caused by an *Ehrlichia* sp. closely related to *E. phagocytophila* and *E. equi* that infect granulocytes. Symptoms are usually nonspecific. The most common complaints are fever, headache, nausea, and muscle and joint pain. Human deaths from ehrlichiosis have been reported in the U.S. The first European case of acute HGE was confirmed in Slovenia in 1996. Little is known about the distribution of ehrlichiosis in Europe, but serological and clinical evidence of human infection reported from several European countries suggests that HGE might exist all over Europe. *Ixodes ricinus* has been implicated as the primary vector in Europe. Seroprevalence of antibodies to *Ehrlichia* spp. in Europe is elevated in high-risk groups exposed to tick bites, such as foresters. The reservoir hosts in Central Europe are unknown but, based on studies in North America, wild rodents, deer and sheep probably play important roles in the epidemiology of ehrlichiosis. Medical personnel should include HGE in the differential diagnosis of febrile illnesses occurring after a tick bite in Europe. The potential for transmission of this pathogen through blood transfusions must also be considered.

P. Murine Typhus. (Flea-borne typhus, Endemic typhus, Shop typhus)

The infectious agent, *Rickettsia typhi*, causes a milder disease than does *R. prowazekii*, but it still results in a debilitating illness with high fever. The incubation period ranges from one to two weeks, and clinical symptoms may last up to two weeks in untreated cases. Mortality is very low, and serious complications are infrequent. The disease is easily treated with antibiotics. Absence of louse infestation, seasonal distribution, and the sporadic occurrence of murine typhus help to differentiate it from epidemic typhus. Murine typhus is often unrecognized and substantially underreported in most endemic areas.

Military Impact and Historical Perspective. Confusion in diagnosis between murine typhus and closely related diseases may occur. Prior to World War II, murine typhus was

not distinguished from the epidemic form, and its importance in prior wars is unknown. During World War II, there were 786 cases in the US Army, with 15 deaths. Only about a dozen cases were recorded in the Mediterranean theater. There are little available data on the incidence of murine typhus during military operations in Korea or Vietnam. During the Vietnam War, murine typhus was concentrated in port cities and incidence seemed low. However, retrospective studies indicated that a large proportion of fevers of unknown origin experienced by Americans during that conflict were due to *R. typhi*. The disease is most common in lower socioeconomic classes and increases when wartime disruptions or mass migrations force people to live in unsanitary conditions in close association with domestic rodents. However, murine typhus has not been a major contributor to disease rates in disaster situations. Because of the sporadic incidence of murine typhus, it is difficult to confidently predict the potential impact of this disease on future military operations, although any such impact would probably be minimal.

Disease Distribution. Murine typhus is one of the most widely distributed arthropod-borne infections and is endemic in many coastal areas and ports throughout the world. Human cases occur principally in urban areas where commensal rodent infestations are common, although infected rodents have been collected from rural villages. Sporadic cases are reported from Central Europe. Most recent outbreaks have occurred in Greece. During the summer of 1985, 49 patients admitted to the Chalkis General Hospital on the Greek island of Evia were diagnosed with murine typhus. An epidemiological study on the island in 1993 found *R. typhi* in 18% of *Rattus norvegicus* and 4% of *Xenopsylla cheopis* fleas. Antibody to *R. typhi* was found in the sera of 92% of the rats. Only eight cases of murine typhus were reported from central Dalmatia, Croatia, between 1978 and 1987. However, 63% of sera from northern Dalmatian islanders had antibodies to *R. typhi*, and 62% of 231 blood donors from the northwestern part of Bosnia and Herzegovina were seropositive. This suggests that many infections are mild or asymptomatic.

Transmission Cycle(s). Murine typhus is a zoonotic infection associated with domestic rats (*Rattus rattus* and *R. norvegicus*) and vectored by their fleas and the spiny rat louse, *Polyplax spinulosa*. The Oriental rat flea, *X. cheopis*, is the most important vector. Neither rodents nor their ectoparasites are affected by infection with *R. typhi*. Inoculating crushed fleas or infective flea feces into the skin at the bite site transmits murine typhus. Scratching fleabites increases the likelihood of infection, but *Rickettsia typhi* is rarely transmitted directly by fleabite. Other routes of infection are inhalation of dry flea feces containing rickettsiae (which may remain infective for months), and ingestion of food contaminated by rodent urine. Murine typhus is not transmitted from person to person. The risk of transmission is year-round but peaks during the warm months.

Although the rat-flea-rat cycle is still the major source of human infection, murine typhus exists in some endemic foci where commensal rodents are absent. In suburban areas of Texas and southern California, the classic enzootic cycle has been replaced by a peridomestic animal cycle involving free-ranging cats, dogs, and opossums and their fleas. In the Dinaric beech-fir forest of southern Slovenia, *Monopsyllus sciurorum* fleas collected from the nests of the fat dormouse, *Glis glis*, were found infected with *R. typhi*. The widespread distribution of this sylvatic flea species of Europe and its presence on other mammalian and avian hosts suggests that murine typhus may exist in unrecognized enzootic cycles.

Vector Ecology Profiles.

The primary vector is the Oriental rat flea, *X. cheopis*. Cat and dog fleas, *Ctenocephalides felis* and *C. canis*, as well as the body louse, *Pediculus h. humanus*, are potential secondary vectors for humans. However, these vectors have not been incriminated in Central European epidemics. The northern rat flea, *Nosopsyllus fasciatus*, spiny rat louse, *Polyplax spinulosa*, and tropical rat mite, *Ornithonyssus bacoti*, are vectors that maintain the enzootic cycle of the disease, although *N. fasciatus* has been incriminated as the primary vector in Croatia and other areas of the former Republic of Yugoslavia. The fleas of Central Europe are listed in Appendix A.4.

Polyplax spinulosa, the spiny rat louse, is closely associated with its rodent hosts. Female lice attach eggs to rodent hairs and all developmental stages live exclusively on rodents. Lice are only transferred from rodent to rodent by body contact. These lice feed on rat blood but do not feed on humans.

Ornithonyssus bacoti, the tropical rat mite, lives on commensal and other rodents throughout the region and feeds on blood and other fluids that ooze from its tiny bite wounds. Engorged females start laying eggs within two days of feeding and continue to lay groups of eggs for two to three days. Eggs hatch in one to two days and develop into larvae, followed by protonymphs and deutonymphs. The entire life cycle, from egg to adult, requires only five to six days. These mites will readily infest humans if their rodent hosts are suddenly eliminated, or if humans live in close association with rodent nests.

The Oriental rat flea, *X. cheopis*, occurs mostly in urban and periurban areas, in conjunction with commensal rodents. Adult fleas feed exclusively on blood and utilize blood protein for egg production. After feeding on a rodent, the female Oriental rat flea lays several eggs (two to 15). Several hundred eggs may be laid during the entire life span. Oviposition most often occurs on the hairs of the host, although the eggs drop off and hatch in the nest or its environs. In locally humid environments, such as rodent burrows, eggs may hatch in as little as two days. Larvae grow rapidly when temperature and humidity are above 25 C and 70% R.H., living in the nest and feeding on dried

blood, dander, and a variety of organic materials. The larval stages can be completed in as little as 14 days (at 30 to 32 C), or as long as 200 days when temperatures drop below 15 C or when nutrition is inadequate. Mature larvae pupate in cocoons, loosely attached to nesting material. Adult emergence may occur in as little as seven days or as long as a year and is stimulated by carbon dioxide or host activity near the cocoon. Adult fleas normally await the approach of a host rather than actively search for one. Fleas feed on humans when people and rodents live close together, but man is not a preferred host. However, if rat populations decline suddenly due to disease or rat control programs, these fleas readily switch to feeding on humans. The life span of adult *X. cheopis* is relatively short compared to that of other flea species, often less than 40 days. Flea populations increase rapidly during periods of warm, moist weather.

The northern rat flea, *N. fasciatus*, also occurs primarily where commensal rodents are found, particularly *R. norvegicus* and *R. rattus*. It has a life cycle similar to that of the Oriental rat flea. *Nosopsyllus fasciatus* lays its eggs in the nests or burrows of commensal rodents. Larvae have the unique habit of attaching to the abdomen of an adult flea and ingesting fecal blood as it passes from the anus of the adult. Adults of this species rarely feed on man. *Nosopsyllus fasciatus* prefers cooler temperatures than *X. cheopis*. Under favorable conditions, the adult life span is just under 100 days. Adults of both *N. fasciatus* and *X. cheopis* can survive unfed for several months.

Vector Surveillance and Suppression. The methods of flea surveillance depend upon the species of flea, the host, the ecological situation, and the objective of the investigation. Fleas can be collected from hosts or their habitat. The relationship of host density to flea density should be considered in assessing flea populations. It has been common practice for years to use a flea index (average number of fleas per host), especially in studies of rodent fleas. For *X. cheopis*, a flea index > 1.0 flea per host is considered high. The flea index has many limitations, since only adults are considered and then only while they are on the host. Fleas are recovered by combing or brushing the host or by running a stream of carbon dioxide through the fur while holding the host over a white surface.

Flea abundance in the environment can be determined by counting the number of fleas landing or crawling in one minute on the lower parts of the legs of the observer. The trouser legs should be tucked into the socks to prevent bites. Flea populations can also be estimated by placing a white cloth on the floor in buildings or on the ground in rodent habitat and counting the fleas that jump onto the cloth. Various flea traps have been devised. Some use light or carbon dioxide as an attractant. Sifting and flotation of rodent nesting materials or of dust and debris from infested buildings are effective methods of collecting fleas from the environment.

Control of rodents over large areas is not feasible during wartime. Control efforts should be limited to foci adjacent to urban areas, military encampments, or other areas frequented by military personnel. If possible, cantonment sites should not be located in wild rodent habitat. Fleas quickly leave the bodies of dead or dying rodents in search of new hosts. Consequently, flea control must always precede or coincide with rodent control operations. Application of insecticidal dusts to rodent burrows is effective in reducing flea populations, but it is very labor intensive. Fleas can be controlled by attracting infested rodents to bait stations. The stations contain an insecticidal dust that rodents pick up while feeding, or a rodent bait containing a systemic insecticide that fleas ingest when taking a bloodmeal. Baiting with systemic formulations may pose environmental risks.

Urban rodent control requires that rodent runs, harborages and burrows be dusted with an insecticide labeled for flea control and known to be effective against local fleas. Insecticide bait stations can also be used. Rat populations should be suppressed by well-planned and intensive campaigns of poisoning and concurrent measures to reduce rat harborages and food sources. Buildings should be rat-proofed to the extent possible to prevent rats from gaining entry. Domestic rodent control is discussed in Technical Guide (TG) 138, Guide to Commensal Rodent Control. Insecticides recommended for flea control are listed in TIM 24, Contingency Pest Management Guide.

Military personnel, especially those involved in rodent control, should use the personal protective measures discussed in TIM 36, Personal Protective Techniques Against Insects and Other Arthropods of Military Significance, and outlined in Appendix F.

Q. Epidemic Typhus.

Epidemic typhus is a severe disease transmitted by the human body louse, *Pediculus humanus humanus*. The infectious agent is the bacterium *Rickettsia prowazekii*. It causes high mortality, particularly in populations weakened by malnutrition. Case fatality rates normally vary from 10 to 40% in the absence of specific therapy. Onset is usually sudden and marked by fever, headache, and general pains followed by a rash that spreads from the trunk to the entire body. Untreated cases of epidemic typhus may last up to 3 weeks. Many humans who contract typhus retain some rickettsiae for the rest of their lives. Under certain stressful conditions or reduced immunity, they may relapse and develop a milder form of typhus known as Brill-Zinsser disease.

Military Impact and Historical Perspective. Epidemics of typhus have changed the course of history. One author has stated that the louse has killed more soldiers than all the bullets fired during conflict. In one of the worst disasters in military history, over half of Napoleon's army perished from epidemic typhus during the invasion of Russia in 1812. During the first year of World War I, typhus started as an epidemic in the Serbian

Army. In six months, 150,000 people had died of the disease, including 50,000 prisoners of war and one-third of Serbian physicians. By the end of the war and during the period immediately following it (1917 to 1923), an estimated 30 million cases of epidemic typhus occurred in Russia and Europe, with over 300,000 deaths. During World War II, there were severe epidemics of typhus in some endemic areas. Large epidemics occurred in Bucovina, northeast Romania and neighboring Moldova. From 1941 to 1944, there were over 132,000 cases in urban areas of French North Africa. Over 91,000 cases occurred in Egypt during the same period. Despite this incidence, US Army personnel experienced only 30 cases of typhus with no typhus deaths in the North African-Middle East-Mediterranean zone during the years 1942 to 1945. When Allied forces landed in Italy in 1943, a typhus epidemic in Naples was ravaging the city of one million. Death rates reached 80%. An effective delousing campaign, chiefly using DDT, was waged. This marked the first time in history that an epidemic of typhus did not exhaust itself but instead was terminated by human action. The US Army achieved a remarkable record of low morbidity with no fatalities from epidemic typhus in World War II by taking effective protective measures against the disease and through the work of the US Typhus Commission established by the Secretary of War on October 22, 1942.

The development of modern antibiotics and insecticides has reduced the threat of this disease to military forces. However, the short incubation period and severe clinical symptoms of epidemic typhus should be of concern to medical personnel when dealing with large concentrations of refugees and prisoners of war. *Rickettsia prowazekii* has the most serious epidemic potential of all rickettsiae, and the emergence and dissemination of body lice can be very rapid under appropriate conditions. In a refugee camp in Goma, Zaire, all 800,000 refugees became infested within one month.

Disease Distribution. Epidemic typhus is more common in temperate regions and in the cooler tropics above 1600 m. It is absent from lowland tropics. It usually occurs in mountainous regions where heavy clothing is worn continuously, such as the Himalayas, Pakistan and Afghanistan, and the highlands of Ethiopia. The incidence of epidemic typhus has been steadily declining in the last two decades. The majority of recent cases have occurred in Africa, primarily in Ethiopia, with most of the remainder occurring in Peru and Ecuador. The most recent outbreak occurred in Burundi, and a small outbreak was observed in Russia in 1997. Epidemic typhus may still be endemic in many parts of Central Europe. Sporadic cases have been reported from Poland and Romania. From 1965 to 1975, there were 623 cases of recrudescent Brill-Zinsser disease recorded from Bosnia and 107 cases recorded from Serbia. Up to 13% of the population in Bosnia and Herzegovina has antibodies to *R. prowazekii*. Endemic areas of epidemic typhus in Central Europe appear in Figure 5.

Until the civil war in the former Republic of Yugoslavia, body louse infestations were uncommon and more likely to be encountered in gypsy populations. An infestation

reported in the Czech Republic in 1991 was the first observation of body lice in that country since 1945. However, over five million persons in the former Republic of Yugoslavia have been displaced by civil war. Large numbers of people are living in crowded, unsanitary conditions. Surveys of refugee camps have found a high incidence of head lice. Though the incidence of body lice has been low, it is expected to increase. The conditions faced by refugees and displaced persons, whether in collective centers or located with host families, are such that the potential for louse-borne disease is high.

Transmission cycle(s). The head louse, *Pediculus humanus capitis*, and the crab louse, *Phthirus pubis*, can transmit *R. prowazekii* experimentally, but epidemics have always been associated with the body louse, *P. h. humanus*. Humans are reservoirs of the pathogen and the only hosts for the lice. Transmission of the disease occurs when individuals wear the same clothes continuously under crowded, unsanitary conditions. Major epidemics have been associated with war, poverty and natural disasters. Persons in cold climates are more likely to acquire epidemic typhus when they are unable to bathe or change clothes for long periods of time.

Lice become infective five to seven days after a bloodmeal from an infected human. During subsequent bloodmeals, the lice defecate and rickettsiae are excreted in their feces. Louse bites are irritating, and scratching by the host produces minor skin abrasions, which facilitate entry of the pathogen from feces or crushed body lice. *Rickettsia prowazekii* can survive desiccation for several weeks. Louse feces are

FIGURE 5. ENDEMIC AREAS OF LOUSE-BORNE TYPHUS IN CENTRAL EUROPE (DARK SHADING)



extremely dry and powdery, so infection may also occur by inhalation of infective louse feces.

The survival of *R. prowazekii* between outbreaks is of interest, since there is no transovarial transmission and lice die from the infection. Individuals who recover from the initial infection and relapse years later with Brill-Zinsser disease are considered the primary reservoir. Lice feeding on such patients become infected. A sylvatic cycle of *R. prowazekii* has been recognized in the southeastern United States, where flying squirrels and their ectoparasites (the flea *Orchopeas howardii* and the louse *Neohaematopinus sciuropteri*) are naturally infected. The louse is host specific, but *O. howardii* has an extensive host range, which includes humans. Sporadic human cases have occurred in houses harboring flying squirrels. The significance of this finding to the epidemiology of epidemic typhus in other areas is not known.

Vector Ecology Profile. Human lice spend their entire life cycle (egg, three nymphal stages and adult) on the host. Eggs of body lice are attached to clothing at a rate of about five to eight eggs per female per day. Lice must mate before egg laying, since females cannot store sperm. At 29°C to 32° C, eggs hatch in seven to 10 days. The maximum time eggs can survive unhatched is three to four weeks, which is important when considering the survival of lice in infested clothing and bedding. A bloodmeal is required for each of the three nymphal molts and for egg production in adults. The nymphal stages are passed in eight to 16 days. Louse populations have the potential to double every seven days. Adults live about two weeks and feed daily. Infestations of lice cause considerable irritation and scratching, which may lead to skin lesions and secondary infections. Body lice are commonly found in the seams and folds of clothing. Lice tolerate only a narrow temperature range and will abandon a dead host or one with a body temperature of 40° C or above. This contributes to the spread of lice and louse-borne disease. Humidity is also critical because lice are susceptible to rapid dehydration. The optimal humidity for survival is between 70% and 90%; they cannot survive at a relative humidity below 40%. Human lice can survive without a host for only a few days.

Vector Surveillance and Suppression. The incidence of head lice has been increasing worldwide. Body louse infestations have declined with higher standards of living, although infestations are still common in some North African populations, especially nomads. The prevalence of body lice reflects the socioeconomic level of the society. The incidence of body lice has increased in some countries due to war and social change. Infestations with body lice are increasingly being reported among the homeless and deprived populations in inner cities of developed nations. Military personnel should avoid close personal contact with infested persons and their belongings, especially clothing and bedding.

Surveillance for body lice consists of examining individuals and their clothing for lice or nits (eggs). The population density of body lice may be very high, but usually only a few lice are observed on an individual. Body lice are frequently found around the waistbands of clothing. Heavily bitten areas, such as the base of the thorax, the groin and the flanks of the body, may become darker. This characteristic skin coloration is often referred to as vagabond's disease.

Dry cleaning or laundering clothing or bedding in hot water (55° C for 20 minutes) will kill eggs and lice. Control of epidemics requires mass treatment of individuals and their clothing with effective insecticides. The permethrin-treated BDU is extremely effective against lice. Since lice cannot survive away from the human host, application of insecticides to buildings, barracks or other living quarters is not necessary. Mass louse control could be hampered by insecticide resistance. Resistance to common pediculicides, particularly DDT and gamma BHC (lindane), is widespread in Central Europe. Pyrethroid lotions and shampoos have been widely used in this region to control head lice, and reports of pyrethroid resistance are increasing. Compounds such as ivermectin, taken orally to eradicate lice, have been investigated experimentally but are not currently registered for that use.

Production of typhus vaccine in the United States has been discontinued, and there are no plans for commercial production of a new vaccine. Vaccination against typhus is not required by any country as a condition of entry.

R. Relapsing Fever (louse-borne). (Epidemic relapsing fever)

Louse-borne relapsing fever is caused by the spirochete *Borrelia recurrentis*. The symptoms and severity of relapsing fever depend on the immune status of the individual, geographic location, and strain of *Borrelia*. The incubation period in an infected host ranges from two to 14 days. The disease is characterized by a primary febrile attack followed by an afebrile interval and one or more subsequent attacks of fever and headache. Intervals between attacks range from five to nine days. In untreated cases, mortality is usually low but can reach 40%. Infection responds well to treatment with antibiotics.

Military Impact and Historical Perspective. Major epidemics of louse-borne relapsing fever occurred during and after World War I in Russia, Central Europe and North Africa. After the war, relapsing fever was disseminated through large areas of Europe, carried by louse-infested soldiers, civilians and prisoners of war. Between 1910 and 1945, there were an estimated 15 million cases and nearly 5 million deaths. Large outbreaks were common during and after World War II, when epidemics of louse-borne relapsing fever in North Africa produced an estimated one million cases and some 50,000 deaths. During the Vietnam War, epidemics of louse-borne fever occurred in the Democratic Peoples' Republic of Vietnam.

Disease Distribution. From 1960 to 1980, louse-borne relapsing fever flourished primarily in the Sudan and Ethiopia. Ethiopia reported the highest number of cases, an estimated 10,000 per year. Relapsing fever is also suspected of persisting in the Peruvian Andes and the Himalayas. Epidemics usually occur in the cold season, among poor people with inadequate hygiene. The potential for outbreaks of relapsing fever in the war-ravaged areas of the former Yugoslavia is high.

Transmission Cycle(s). The body louse, *P. h. humanus*, is the vector of *B. recurrentis*. After the louse feeds on infective blood, the spirochetes leave the digestive tract and multiply in the insect's body cavity and other organs. They do not invade the salivary glands or the ovaries and are not found in the feces. Bites and fecal deposits cannot transmit the pathogen, and transovarial transmission does not occur. Human infection occurs when a louse is crushed and *Borrelia* spirochetes are released. The spirochetes may be scratched into the skin or come in contact with mucous membranes, but there is evidence that *B. recurrentis* can penetrate unbroken skin. Since infection is fatal to the louse, a single louse can infect only one person. However, *B. recurrentis* can survive for some time in a dead louse. Outbreaks of louse-borne relapsing fever require high populations of body lice. Lice leave febrile patients in search of new hosts, and this behavior contributes to the spread of disease during an epidemic.

Humans are the only known reservoir for *B. recurrentis*. Mechanisms of survival during non-epidemic periods are unknown. The life cycle of the body louse is less than two months, and in the absence of transovarial transmission *B. recurrentis* cannot survive in the louse population.

Vector Ecology Profile. See epidemic typhus.

Vector Surveillance and Suppression. See epidemic typhus.

S. Other Arthropod-borne Viruses.

Many enzootic arboviruses are circulating in Central Europe, but little is known about them. Available epidemiological information indicates that they would have a minor impact on military operations. However, medical personnel should be aware of these arboviruses because they will frequently be treating fevers of unknown origin.

Vesicular stomatitis (VS) is a serious viral disease of cattle, horses and swine that has caused enormous economic loss in many areas of the world. A group of related viruses constitute the genus *Vesiculovirus* in the family Rhabdoviridae. Human infections with VS virus have occurred under natural conditions during epizootics and as the result of laboratory accidents. Most human infections occur in veterinarians and livestock handlers who have direct contact with large domestic animals. The natural history of VS viruses, including their endemic and epizootic patterns, is poorly understood. VS viruses

have been isolated from a wide variety of blood-sucking insects, including mosquitoes, black flies and biting midges. However, VS virus can seldom be isolated from the blood of an infected animal, and viremias are usually insufficient to infect blood-sucking arthropods. VS viruses have also been isolated from nonhematophagous Diptera, such as eye gnats and house flies, and mechanical transmission of VS virus has been demonstrated experimentally. A VS virus named Yug Bog Danovac has been isolated from *Phlebotomus perfiliewi* in southeastern Serbia. Antibodies to this virus have been detected in humans, but its role in human disease is unknown.

In Central Europe, Lednice (*Bunyavirus*, Bunyaviridae) virus has been isolated only from *Culex modestus* in southern Moravia, Slovakia. Little is known about its natural history or role in human disease. Low levels of viremia have been produced experimentally in birds but not in the several species of mammals tested. Antibodies to Lednice virus have been detected in wild geese and ducks in Slovakia and Romania.

Human infection with Batai virus (*Bunyavirus*, Bunyaviridae) produces a fever and occasionally a meningitis syndrome. The virus, also called Calovo virus, has been isolated from mosquitoes in northeastern Croatia and southern Moravia, Slovakia. The large number of field isolates from *Anopheles maculipennis* makes this species a candidate for further vector studies. Available serological data indicate cattle as the principal vertebrate host.

Uukuniemi (*Uukuvirus*, Bunyaviridae) virus has been isolated from *Ixodes ricinus* in the Czech and Slovak Republics, Hungary and Poland. Antibodies to this virus have been detected in humans, but its role in human disease is unknown.

Viruses of the Kemerovo group form a distinct serogroup in the genus Orbivirus, family Reoviridae. Two Kemerovo group viruses, Tribec and Lipovnik, isolated in Central Europe have been incriminated as causes of human illness. Both viruses are transmitted by ticks, and serological evidence of infection has been found in domestic animals. However, the complete natural cycle of these viruses and their role in human disease is unknown. Isolations of both viruses have been reported from Slovakia and Romania. Lipovnik virus has been isolated from *I. ricinus* in Slovakia, and during the mid 1980s antibodies to this virus were found in up to 88% of the goats and up to 30% of the inhabitants of the Silica plateau area of the Slovak karst region. In Slovakia, antibodies to Tribec virus were found in cerebrospinal fluid of patients with inflammatory neurologic disorders.

VI. Militarily Important Vector-borne Diseases with Long Incubation Periods (>15 days)

A. Leishmaniasis.

This potentially disfiguring and sometimes fatal disease is caused by infection with protozoan parasites of the genus *Leishmania*. Transmission results from bites of infected phlebotomine sand flies. All vectors of leishmaniasis in the Old World are in the sand fly genus *Phlebotomus*. Incubation in humans may take as little as ten days or more than six months. Symptoms include ulcerative cutaneous lesions (cutaneous leishmaniasis or CL), lesions in the mucosal areas of the mouth and/or nose (mucocutaneous leishmaniasis or MCL), and internal pathological manifestations resulting in fever, swollen lymph glands, anemia, enlargement of the liver and spleen, and progressive emaciation and weakness (visceral leishmaniasis or VL). In Central Europe, both CL and VL are important public health problems except in the Czech Republic, the northern two thirds of Hungary, Poland, the northern half of Romania, and the Slovak Republic.

CL (Baghdad boil or Oriental sore), caused by infection with *Le. tropica*, typically appears as a nonhealing ulcer. The lesion usually develops within weeks or months after a sand fly bite and slowly evolves from a papule to a nodule to an ulcer. Cutaneous lesions may resolve quickly (two to three months) without treatment or they may become chronic (lasting months to years) and will seldom heal without treatment. Scarring is associated with healing. In endemic areas, such scars are common among rural and urban populations. Life-long immunity to the infecting *Leishmania* species normally results.

VL (Kala-azar, Dum Dum fever), caused by *Le. infantum*, is a severe form of leishmaniasis, with as much as 95% mortality in untreated cases. It is a chronic disease that without treatment is marked by fever (two daily peaks), weakness and, as the parasites invade internal organs, weight loss coupled with enlargement of spleen and liver that may resemble severe malnutrition. It should be noted that cutaneous lesions may also be seen in human visceral leishmaniasis cases, but the chronic visceralizing nature of the disease is the main concern. In Central Europe, VL is usually attributed to *Le. infantum*. Viscerotropic *Le. tropica* has also been reported and was described in veterans of the Persian Gulf war. The incubation period for VL is usually four to six

months but may be as short as 10 days or as long as two years. By the time the disease is diagnosed, patients have usually forgotten any contact with sand flies. In endemic regions it is a disease of the young and old, who succumb to it disproportionately. Epidemics of VL often follow conditions of severe drought, famine or disruption of native populations by wars that produce large numbers of refugees. In Sudan, between the years 1991 and 1996, there were reports of 10,000 treated cases and an estimated 100,000 deaths from untreated cases of VL.

Military Impact and Historical Perspective. Leishmaniasis is a persistent health threat to U.S. military personnel because troops deploy or conduct military exercises in locations where the disease is endemic. The potential for this disease to compromise mission objectives is significant. Soldiers exposed to sand fly bites while deployed are highly susceptible to infection with *Leishmania tropica*. Immunity among US military personnel is essentially nonexistent, and recovery from CL does not confer immunity to VL. In the Karum River Valley of Iraq, US forces suffered 630 cases of the disease in a three-month period during WWII. From 1990 to 91, 12 cases of VL due to *Le. tropica* were diagnosed when 697,000 allied soldiers were deployed to the Arabian Peninsula during Operations Desert Shield and Storm. Even though no fatalities were associated with leishmaniasis in this deployment, new lessons were learned that could affect future military deployments. Before the Persian Gulf War, eastern Saudi Arabia was not known to be endemic for visceral leishmaniasis, and *Le. tropica* was not convincingly shown to produce visceral disease. More important, the potential for leishmaniasis to cause intransigent post-deployment diagnostic problems and threaten blood supplies had not been anticipated. Returnees from the Persian Gulf War were barred from donating blood for up to two years, severely impacting blood supplies. Infection with *Leishmania* was even suspected as one of the causative agents of Persian Gulf War syndrome, but scientific evidence for this association was never established.

Diagnosis of leishmaniasis is difficult at best, and providing proper care for service members who may have been exposed or infected is a long, costly and complex process. Treatment usually requires 20 or more days and consists of injections with pentavalent antimony (Pentostam). Because this drug is not registered for use in the US, it must be administered under an experimental protocol at an approved medical treatment facility. Estimated leishmaniasis-related costs can exceed US \$17,000 per patient, with an average of 92 lost duty days per patient. Other important but less quantifiable costs include loss to the unit, personal distress, and delay of career progression.

Disease Distribution. Anthroponotic (human-to-human) transmission of CL due to *Le. tropica* occurs in urban centers and rural highland villages in Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Romania, Serbia and Montenegro, and Slovenia (Figure 6). The disease is widespread in areas with a temperate climate

(Mediterranean Basin), or a cold, arid climate (Transcaucasian region, Afghanistan, etc.).

VL due to *Le. infantum* occurs in the Mediterranean Basin countries of North Africa, the Middle East, southern Europe, East Africa, south-central Asia, and China. In Central Europe, it is reported from parts of Hungary and Romania and in the countries of Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Macedonia, Serbia and Montenegro, and Slovenia (Figure 7). It is not highly endemic in any of these countries. In Albania, Croatia and Greece, the etiological agent of VL has been incorrectly reported as *Le. donovani* due to improper interpretation of the subspecies name *Le. donovani infantum*, which is correctly designated as *Le. infantum*.

FIGURE 6. ENDEMIC AREAS OF CUTANEOUS LEISHMANIASIS IN CENTRAL EUROPE (DARK SHADING)



FIGURE 7. ENDEMIC AREAS OF VISCERAL LEISHMANIASIS IN CENTRAL EUROPE (DARK SHADING)



Transmission Cycles. In urban areas humans may serve as reservoirs of *Le. tropica*. In rural areas, non-human hosts of *Le. tropica* may include wild and domestic rodents living in close proximity to humans. Sand fly vectors inhabit the burrow systems of domestic and wild rodents, moles, hedgehogs and jerboas, and acquire infections while feeding on these reservoir hosts. Amastigotes (the mammalian form of the *Leishmania* parasite) ingested with the bloodmeal transform to a flagellated promastigote form within the gut of the female fly. In addition to a bloodmeal, the female consumes sugar in the nectar of nearby plants during subsequent nocturnal flights. These sugars help maintain *Leishmania* infections in the flies. Promastigotes multiply within the bloodmeal in the gut of the sand fly and undergo development to an infective form called the metacyclic promastigote. By the time the bloodmeal is digested and the fly is ready to lay its eggs, infective metacyclic promastigotes are ready to be transmitted to the next vertebrate host when the sand fly feeds again (Figure 8).

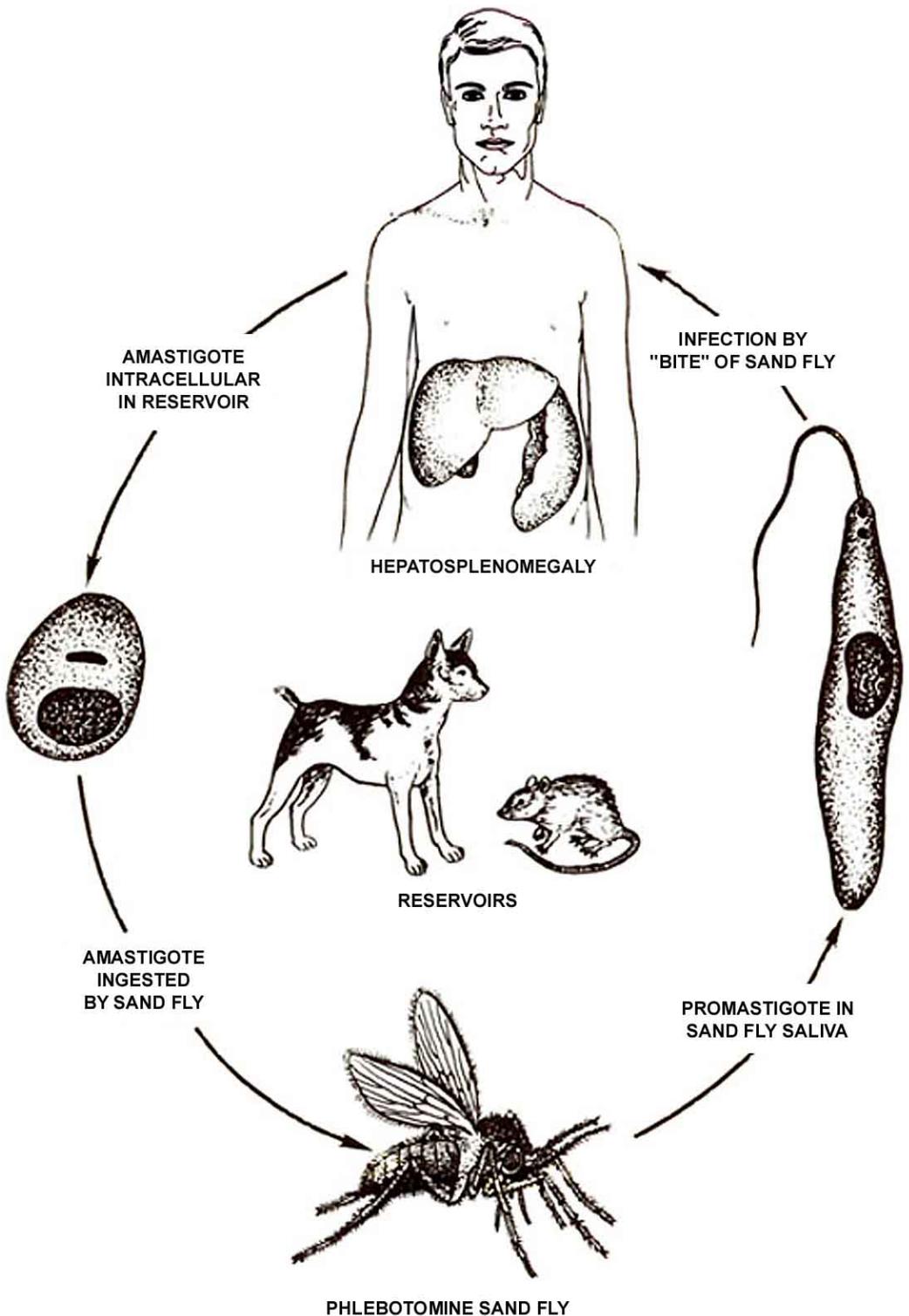
Infective-stage promastigotes (metacyclics) are deposited in the skin of a susceptible host during the sand fly's next bloodmeal. Promastigotes are engulfed by white blood cells or macrophages, in which they transform to amastigotes. Amastigotes proliferate in the macrophage until it ruptures and new macrophages are invaded. At the skin surface, the tiny bite site becomes a small red papule that enlarges and ulcerates, with a raised edge of red inflamed skin. This inflamed area is where macrophages continue to engulf parasites, resulting in additional parasite multiplication. The ulcerated sores may become painful, last for months and, in uncomplicated CL caused by *Le. tropica*, eventually heal to form the characteristic scars seen on large numbers of people in some endemic areas of the region.

The incriminated vector of *Le. tropica* in Central Europe is *P. sergenti*, though *P. papatasi* is a suspected vector. The form of CL known as "dry sore" is most common in densely populated urban centers and is considered to have a human-sand fly-human (anthroponotic) transmission cycle, with no recognized sylvatic reservoir. In recent years, CL due to *Le. tropica* has been reported in rural highland villages of Central Europe. In these foci, the disease is thought to have a zoonotic transmission cycle in which *P. caucasicus* maintains transmission within a wild rodent reservoir population. However, a sylvatic reservoir has not been identified.

The cycle of development of parasites causing VL is essentially the same as described for CL. The differences when dealing with VL caused by *Le. infantum* are the species of sand flies that vector the disease and the reservoirs for the parasite. In Central Europe, VL is a zoonotic disease of wild canids. It has been isolated from jackals and foxes in rural areas, as well as from feral and domestic dogs. Incidental infections occur in humans living in close association with infected dogs. In addition to wild and domestic canids, and man, *Le. infantum* has been isolated from infected rats (*Rattus rattus*) in southern Saudi Arabia, expanding the list of potential reservoirs. As previously

mentioned, a less virulent, viscerotropic form of *Le. tropica* has been reported from the Middle East.

FIGURE 8. LIFE CYCLE OF *LEISHMANIA*



Vector Ecology Profiles. The incriminated vector of *Le. tropica* in the region is *P. sergenti*. Suspected vectors of *Le. tropica* are *P. alexandrei*, *P. papatasi* and *P. perfiliewi*. Proven or suspected vectors of *Le. infantum* in Central Europe are *P. caucasicus*, *P. longiductus*, *P. neglectus*, *P. perfiliewi*, *P. perniciosus*, *P. simici* and *P. tobbi*.

Adult sand flies rest during the daytime in dark, humid, protected areas, such as rodent burrows, rock crevices and caves. The preparation of military bunkered ground positions in desert areas provides additional protected daytime resting sites for phlebotomine sand flies. In urban areas, sand fly adults often rest in dark, cool, humid areas of human habitations and animal structures. Abandoned structures and their vegetative overgrowth often become attractive wild or domestic rodent habitats and foci of rural CL.

Nectar is important as a sugar source for both male and female sand flies, since sugars are required for development of parasite infections. After a bloodmeal, eggs are deposited in dark, humid, secluded areas. They develop into minute caterpillar-like larvae that feed on mold spores and organic debris. The larvae go through four instars and then pupate near larval feeding sites. Development from egg to adult requires 30 to 45 days, depending on feeding conditions and environmental temperatures. Phlebotomine sand fly eggs, larvae and pupae have seldom been found in nature, although exhaustive studies and searches have been made. The adult female has been observed to spread eggs around rather than oviposit in a single site. The larvae are widely distributed in the environment but are probably below the ground surface in termite mounds, rodent burrows, caves, or cracks and crevices in the soil where temperature, humidity and mold growth provide ideal conditions for larval development.

The dusk-to-dawn movement of adults is characterized by short, hopping flights just above the ground surface to avoid wind. Adult sand flies generally do not travel great distances, and most flights are believed to be less than 100 meters. Sand fly habitats in the region range in altitude from desert areas below sea level up to 2,800 m in the mountains. In temperate climates adult sand flies are most abundant and active in the warmer months of April through October, especially after rains. However, species of sand flies such as *P. sergenti* are tolerant of cold winters, and *P. mascittii*, found in northern latitudes, will bite man in cool conditions. Both *P. sergenti* and *P. papatasi* will bite humans either indoors or outdoors and are troublesome pest species.

Female sand flies are quiet "stealth biters" from which comes the name "*papataci*" (silent gorger), and their bites may go unnoticed by military personnel. Sand flies may also bite during the daytime if disturbed in their secluded resting sites. Areas with some vegetation and cliffs, rock outcroppings, or other geologic formations that provide suitable hiding places and daytime resting sites are important habitats. Exact information on reservoirs and vectors will require more extensive study in many countries of the

region. Vast areas of these countries remain unsurveyed for sand fly vectors and disease. When searches are made, sand fly vectors are often found in areas where they were previously unknown.

Vector Surveillance and Suppression. See sand fly fever.

B. Lyme Disease.

Lyme disease is also called Lyme borreliosis, tick-borne meningopolyneuritis and Lyme arthritis. The causative agent is the spirochete bacterium *Borrelia burgdorferi*. At least four genospecies of the Lyme disease spirochete have been isolated in Central Europe: *B. burgdorferi* sensu stricto, *B. afzelii*, *B. garinii* and *B. valaisiana* (formerly group VS116). *Borrelia afzelii* and *B. garinii* predominate in the region. Like syphilis, the clinical disease manifests itself in acute and chronic stages. Initially there is a highly characteristic expanding skin lesion (erythema migrans) that develops in about 60% of cases. Flu-like symptoms usually occur about the same time. Weeks to months after initial infection, cardiac, neurological or arthritic symptoms and other joint abnormalities may occur and persist for years. Different genotypes have been associated with characteristic clinical symptoms. *Borrelia afzelii* prevails in skin lesions, whereas *B. garinii* is associated with neurological involvement. Treatment in the late stages of Lyme disease can be difficult, and chronic infection can be very debilitating. Early recognition and treatment are critical.

Military Impact and Historical Perspective. Lyme disease is an emerging infection of public health importance in many parts of the world. Since its recognition in Connecticut during the 1970s, Lyme disease has been reported from 48 states. The development of effective vaccines, absence of antibiotic resistance in *B. burgdorferi* spirochetes, and availability of highly effective repellents should minimize the military impact of Lyme disease. Since 1995, about 100 cases of Lyme disease have been officially reported in US Army personnel worldwide.

Disease Distribution. Lyme disease is the most common tick-borne infection of humans in the temperate Northern Hemisphere, including North America, Europe and northern Asia. Lyme-like syndromes have been reported from South America, Africa, tropical Asia and Australia, but their epidemiology has not been clarified. Clinical and serological evidence of Lyme disease in humans has been reported throughout Central Europe. It is difficult to compare published results from different European labs using different diagnostic tests. Incidence of antibodies to *B. burgdorferi* is correlated with exposure to tick habitat. Nearly 40% of forestry workers in eastern Poland showed a positive antibody response in a 1997 survey, while only 6% of the general population of blood donors were seropositive. Nearly 35% of foresters from various regions in Bulgaria were seropositive. The highest incidence of Lyme disease antibodies occurs in Croatia (43%), while the lowest seroprevalence to *B. burgdorferi* in the region (1.1%) has

been reported from Greece. There are few reports in the medical literature about the seroprevalence of Lyme disease in Albania.

Incidence of infection has been increasing in most countries of Central Europe. In the Czech Republic, 6,302 cases of Lyme disease were reported in 1995 and 4,192 cases were reported in 1996. *Borrelia burgdorferi* was isolated from 231 patients during 1994 at the Medical Center Ljubljana, Slovenia. From 1991 to 1995, 2,357 people were diagnosed with Lyme borreliosis in Slovakia. Even suburban areas and urban parks may be active foci of Lyme disease. Approximately 10% of *I. ricinus* nymphs and adults collected in suburban and urban wooded areas of southern Poland were infected with *Borrelia burgdorferi* in 1996. In the same year, another study found that 19.2% of *I. ricinus* collected from urban areas in Warsaw and 31% of *I. ricinus* collected from forests near Warsaw were infected. Infection rates in *I. ricinus* collected from 10 localities in Prague between 1994 and 1997 ranged from 3.6% to 11.3%.

Borrelia burgdorferi was isolated from 19% of the *I. ricinus* ticks collected from six regions of Slovakia in 1993. Up to 34% of *I. ricinus* collected at 12 sites in the foothill areas of Veliko Tarnovo, Bulgaria, from 1989 to 1990 were infected with Lyme disease spirochetes. Some of the highest infection rates in the region have been recorded from Croatia. Forty-five percent of *I. ricinus* collected from an enzootic region in northern Croatia were infected, and 21% of the roe deer sampled were seropositive in northwest Croatia. Hungary has recorded a countrywide incidence of 50 cases per 100,000.

Transmission Cycle(s). All known primary vectors of Lyme disease are hard ticks of the genus *Ixodes*, subgenus *Ixodes*. Infective spirochetes are transmitted by tick bite. Nymphal ticks usually transmit the disease to humans. Transmission of the pathogen often does not occur until the tick has been attached for at least 24 hours, so early tick detection and removal can prevent infection. *Borrelia burgdorferi* has been detected in mosquitoes, deer flies and horse flies in the northeastern United States and Europe, but the role of these insects in Lyme disease transmission appears to be minimal. Rodents, insectivores and other small mammals maintain spirochetes in their tissues and blood and infect larval ticks that feed on them. Infection with more than one genotype has been found in ticks as well as vertebrate reservoirs. Spirochetes are seldom passed transovarially by female ticks. Small mammals vary in their relative importance as reservoir hosts in different geographic regions. Field mice in the genera *Apodemus* and *Clethrionomys* are the chief reservoirs across Eurasia. Experimental studies suggest that birds are poor hosts of Lyme disease spirochetes and play an insignificant role as reservoirs. Birds are involved in the circulation of *B. burgdorferi* principally as disseminators of infected ticks to new areas. Large mammals, especially deer, are important as hosts of adult ticks and essential to completion of the life cycle of the vector, but are unimportant as reservoirs of the pathogen.

Vector Ecology Profiles.

Ixodes ricinus is the principal vector of Lyme disease in Europe and around the Mediterranean Sea, although other *Ixodes* spp. are possible vectors. *Ixodes ricinus* is either reported or suspected from every country in Central Europe. Secondary vectors in the region include *Haemaphysalis concinna*, *H. punctata*, *Dermacentor marginatus* and *Rhipicephalus bursa*. The vector ecology profiles of these species, except *Rhipicephalus bursa*, are described in the section on tick-borne encephalitis. Consequently, only the biology of *R. bursa* is discussed here. Central European tick species and their distributions appear in Appendix A.3. The biology of tick vectors is summarized in Appendix B.

Rhipicephalus bursa is a medium-sized, two-host tick that is widely distributed in most of the countries bordering the Mediterranean and occurs in nearly all biotopes of Greece except for wet, marshy areas. It also occurs in Bulgaria and Serbia, and probably occurs in Romania, Albania, Macedonia, Croatia and Bosnia. In Greece, immature stages of this species appear during the autumn and winter. They may infest hares but more often attack cattle or sheep. Larvae and nymphs attach to their hosts from three to 10 days, while adult females may attach for five to 12 days. Adults are most active during the spring to early summer period. Adults readily feed on cattle, sheep, goats and, to a lesser extent, dogs. Since man is rarely attacked, *R. bursa* is significant only in the zoonotic cycle of Lyme disease. Adults of this species frequently attach around the anus, vulva, udder, or scrotum of cattle. The female tick takes large bloodmeals, often increasing its body weight by 9,000 percent. Males also engorge but increase their weight by only 100 to 200%. Females that have fully engorged produce 3,000 to 6,000 eggs. This species has been known to reproduce parthenogenetically.

Vector Surveillance and Suppression. There are several methods that can be used to determine the numbers and species of ticks in a given area. These include dragging a piece of flannel cloth over vegetation where ticks are waiting for a passing host and collecting the ticks that attach to the cloth, collecting ticks from animal hosts or their burrows/nests, attracting ticks to a trap using carbon dioxide (usually in the form of dry ice), and removing ticks from a person walking in a prescribed area. Different species and life stages of ticks are collected disproportionately by the various methods, and techniques selected must be tailored to the species and life stage desired. These collection procedures are discussed thoroughly in TIM 26, Tick-borne Diseases: Vector Surveillance and Control.

Habitat modification can reduce tick abundance in limited areas. Mechanical removal of leaf litter, underbrush, and low-growing vegetation reduces the density of small mammal hosts and deprives ixodid ticks of the structural support they need to contact hosts. Leaf litter also provides microhabitats with environmental conditions suitable for survival,

such as high relative humidity. Controlled burning, where environmentally acceptable, has been shown to reduce tick populations for six to 12 months.

Large-scale application of pesticides to control ticks is usually impractical and may be environmentally unacceptable at military installations during peacetime. Chemical treatment should be confined to intensely used areas with a high risk of tick-borne disease. Liquid formulations of pesticides can be applied to vegetation at various heights to provide immediate reduction in tick populations. Granular formulations provide slower control and only affect ticks at ground level. Both formulations give approximately the same level of control when evaluated over a period of several weeks. Consult TIMs 24 and 26 for specific pesticide recommendations and application techniques.

Exclusion of deer and other large animals using electric or nonelectric fences has reduced populations of *Ixodes* ticks that require large animals to complete their life cycle. This technique would have limited applicability in most military situations.

The **personal protective measures** discussed in TIMs 26 and 36 are the best means of protecting individual soldiers from tick bites. Clothing impregnated with permethrin is particularly effective against crawling arthropods like ticks. Frequent body checks while operating in tick-infested habitat are essential. Tick attachment for several hours is required for transmission of many tick-borne pathogens, so early removal of ticks can prevent infection (Appendix F).

The FDA has approved LYMERix, a vaccine developed by SmithKline Beecham, for vaccination of people ages 15 to 70. The vaccine is only about 80% effective, and it takes three shots over a full year to build optimal immunity. It protects only against North American strains of *B. burgdorferi* and is not effective against European genotypes of the spirochete. Therefore, vaccinated individuals must still use **personal protective measures** against ticks.

VII. Other Diseases of Potential Military Significance.

A. Leptospirosis. (Weil disease, Canicola fever, Hemorrhagic jaundice, Mud fever, Swineherd disease)

The spirochete bacterium *Leptospira interrogans* is the causative agent of this zoonotic disease. More than 200 serovars of *L. interrogans* have been identified, and these have been classified into 23 serogroups based on serological relationships. Common clinical features are fever with sudden onset, headache, and severe muscle pain. Serious complications can occur. Infection of the kidneys and renal failure is the cause of death in most fatal cases. The severity of leptospirosis varies greatly and is determined to a large extent by the infecting strain and health of the individual. In some areas of enzootic leptospirosis, a majority of infections are mild or asymptomatic. The incubation period is 10 to 12 days after infection.

Disease Distribution. Distribution is worldwide in urban and rural areas of both developed and developing countries. Leptospirosis is regarded as focally enzootic throughout Central Europe, and sporadic human cases are reported from most countries as a result of occupational exposure. Human cases of leptospirosis have been contracted from bathing in some rivers of Central Europe. All 18 outbreaks of leptospirosis in Romania between 1978 and 1984 occurred after swimming or bathing in rivers. An epidemiological study in Slovakia from 1970 to 1991 found a 50% decline in the incidence of the leptospirosis, although over 500 cases were reported from Bosnia and Herzegovina in 1995.

Transmission Cycle(s). Numerous wild and domestic animals act as reservoirs, including rodents, raccoons, deer, bear, boar, foxes, squirrels, swine, cattle, sheep, goats, and horses. Cats and dogs are frequently infected but are probably insignificant as a source of infection to humans. Dogs are a good indicator of the distribution of different leptospiral serovars in the environment. Many small mammals are involved in the epidemiology of leptospirosis in Central Europe. The common vole, *Microtus arvalis*, and the striped field mouse, *Apodemus agrarius*, are important reservoirs in addition to domestic rodents. Because of its prevalence in rodents and domestic animals, leptospirosis has usually been an occupational hazard to farmers, sewer workers, veterinarians, animal husbandry workers, slaughterhouse workers, and rice and sugarcane field workers. *Leptospira* infect the kidneys and are transmitted in the urine of infected animals. Humans become infected through contact of skin or mucous membranes with contaminated water, moist soil or vegetation. *Leptospira* survive only in fresh water. Spirochetes are not shed in the saliva; therefore, animal bites are not a source of infection. Although infected humans shed *Leptospira* in urine, person-to-person transmission is rare. Infection may occasionally occur by ingestion of food contaminated with urine from infected rats. Infection from naturally infected meat or milk is low. Spirochetes disappear from whole milk within a few hours.

Disease Prevention and Control. To prevent leptospirosis, control domestic rodents around living quarters and food storage and preparation areas. *Leptospira* are readily killed by detergents, desiccation, acidity, and temperatures above 60°C. Good sanitation reduces the risk of infection from commensal rodents. Troops should be educated about modes of transmission and instructed to avoid swimming or wading in potentially contaminated waters. Leptospirosis could be a problem following flooding of contaminated streams or rivers. Vaccines have been used effectively to protect workers in veterinary medicine, and immunization has also been used to protect against occupational exposure to specific serovars in Japan, China, Italy, Spain, France, and Israel. Short-term prophylaxis may be accomplished by administration of antibiotics. Doxycycline was effective in Panama in preventing leptospirosis in military personnel.

B. Hantaviral Disease. [Epidemic hemorrhagic fever, Korean hemorrhagic fever, Nephropathia epidemica, Hemorrhagic nephrosonephritis, Hemorrhagic fever with renal syndrome (HFRS), hantavirus pulmonary syndrome (HPS)]

Hantaviruses are a closely related group of zoonotic viruses that infect rodents. The genus *Hantavirus*, family Bunyaviridae, comprises at least 14 viruses, including those that cause HFRS and HPS. Syndromes in humans vary in severity but are characterized by abrupt onset of fever, lower back pain, and varying degrees of hemorrhagic manifestations and renal or pulmonary involvement. Depending in part on which hantavirus is responsible for illness, HFRS can appear as a mild, moderate or severe disease. Severe illness is associated with Hantaan virus (HTN) and Seoul virus (SEO), primarily in Asia and the Balkans. The case fatality rate is variable but is about 5% in Asia and somewhat higher in the Balkans. Convalescence takes weeks to months. A less severe illness caused by Puumala virus (PUU) and referred to as nephropathia epidemica predominates in Europe. Dobrava-Belgrade (DOB) virus has caused severe HFRS cases in several countries surrounding Turkey, with mortality rates of up to 20%. Tula virus (TUL) has been isolated throughout Europe and eastward to the Kirov region, Russia, but its role in human disease is unclear. HPS, caused by several hantaviruses, has been reported throughout North and South America.

Military Impact and Historical Perspective. Prior to World War II, Japanese and Soviet authors described HFRS along the Amur River in Manchuria. An epidemic of “trench nephritis” during World War I may have been due to hantaviral infection. Thousands of cases of this illness, considered an entirely new disease, were noted on both sides of the front. During World War II, more than 10,000 cases of a leptospirosis-like disease were recorded during the 1942 German campaign in Finnish Lapland. When the snow melted, great numbers of lemmings and field mice invaded German bunkers. In 1951, HFRS was recognized among United Nations troops in Korea and has been observed in both military personnel and civilians since then.

Hantaviral disease is an emerging medical threat to military forces operating in many areas of the world. Over 20 acute PUU infections were documented in US Army personnel during a 1990 field exercise in southern Germany. Several outbreaks of hantaviral disease occurred in 1995 as a result of the civil war in the states of the former Yugoslavia. Over 300 patients, most of them soldiers exposed in the field, were hospitalized in the Tuzla region (northeast Bosnia) with acute hantaviral disease. Outbreaks also occurred around Sarajevo and Zenica. Croatia reported over 200 cases from several localities. A study the following year in central Croatia found 11% of sampled rodents were infected with HTN. Over 100 cases were reported in northern Montenegro. Hantaviral infections also occurred during the fighting in Kosovo. Advanced diagnostic techniques have led to increasing recognition of new hantaviruses and hantaviral infections globally. New outbreaks with novel hantaviral strains are still being uncovered. The distribution of new and old strains of hantaviruses presents a complex and confusing epidemiological picture of this emerging disease, but the military threat is significant.

Disease Distribution. At least 200,000 cases of HFRS involving hospitalization are reported annually throughout the world. Hantaan virus claims 40,000 to 100,000 victims annually in China. South Korea has reported about 1,000 cases annually in recent years. In Central Europe, at least 4 hantaviruses (PUU, DOB, HTN and TUL) are enzootic, primarily in rural and semirural areas. SEO virus is associated with the commensal Norway rat and occurs in more urban areas. Most clinical cases are reported from the Balkans. PUU infections predominate but most infections are subclinical. Prevalence of hantaviral antibodies in endemic areas increases with age. During the 1990s, outbreaks of Dobrava virus were reported from the Albanian southern Karst Mountain region, in neighboring Greece, and Bosnia and Herzegovina.

Transmission Cycle(s). Virus is present in the urine, feces and saliva of persistently infected, asymptomatic rodents. Aerosol transmission to humans from rodent excreta is the most common mode of infection. Human-to-human transmission of HFRS is considered rare, although viruses have been isolated from the blood and urine of patients. Hantaviruses have caused laboratory-associated outbreaks of infection.

Each hantavirus appears to have a single predominant murid reservoir. HTN is commonly associated with the field mouse, *Apodemus agrarius*, in open field or unforested habitats. The red bank vole, *Clethrionomys glareolus*, inhabits woodland or forest-steppe environments and is a primary reservoir for PUU. DOB has been isolated from the yellow-necked field mouse, *Apodemus flavicollis*, in open field and unforested foothills. The Norway rat, *Rattus norvegicus*, is the reservoir for SEO worldwide. The common European vole, *Microtus arvalis*, appears to be the primary reservoir of TUL. Hantavirus infection is not pathogenic in its rodent reservoir and produces chronic and

probably lifelong infection. Hantaviruses may be spread by infected rodents that infest ships, thereby reaching ports worldwide.

The risk of transmission is highest in warm months when rodent reservoir populations are abundant. Military personnel are exposed to infection when working, digging or sleeping in fields infested by infected rodents.

Disease Prevention and Control. Exclude or prevent rodent access to buildings. Store food in rodent-proof containers or buildings. Disinfect rodent-contaminated areas with dilute bleach or other antiviral agents. Do not sweep or vacuum rodent-contaminated areas; use a wet mop moistened with disinfectant. Eliminate wild rodent reservoirs before military encampments are established in fields. Do not disturb rodent droppings or sleep near rodent burrows. Military personnel should not tame wild rodents. Rodents frequently urinate or bite when handled. Detailed information on surveillance and personal protective measures when working around potentially infected rodents can be found in TIM 40, Methods for Trapping and Sampling Small Mammals for Virologic Testing, and in TIM 41, Protection from Rodent-borne Diseases.

VIII. Noxious/Venomous Animals and Plants of Military Significance.

A. Arthropods.

Annoyance by biting and stinging arthropods can adversely affect troop morale. The salivary secretions and venoms of arthropods are complex mixtures of proteins and other substances that are allergenic. Reactions to arthropod bites and stings range from mild local irritation to systemic reactions causing considerable morbidity, including rare but life-threatening anaphylactic shock. Insect bites can be so severe and pervasive that they affect the operational readiness of troops in the field. Bites and their discomfort have been a major complaint by soldiers deployed in many regions of the world.

Entomophobia, the irrational fear of insects, and the related arachnophobia, fear of spiders, are two of the most common human phobias. The fear is usually not limited to obvious threats, such as scorpions. The anxiety produced in a fearful individual by a potential encounter with an insect ranges from mild aversion to panic. The degree of negative response to encounters with insects or spiders is important in assessing the difference between common fear and true phobia. Common fear is a natural extension of human experience and is appropriate to situations that involve potential danger or require caution. Phobias, however, are characterized by persistent, high levels of anxiety in situations of little or no threat to the individual. Many individuals may express a fear of insects or spiders, but few are phobic to the extent that their ability to function in a normal daily routine is impaired by their fear. The term delusory parasitosis refers to a

mental disorder in which an individual has an unwarranted belief that insects or mites are infesting his or her body or environment. This psychiatric condition is distinct from entomophobia or an exaggerated fear of real insects. Extreme entomophobia and delusory parasitosis require psychological treatment.

The following groups of noxious arthropods are those most likely to be encountered by military personnel operating in countries of Central Europe:

1. Acari (ticks and mites). Tick paralysis is a potentially fatal but easily cured affliction of man and animals. It is almost exclusively associated with hard (ixodid) ticks and is presumably caused by injection of neurotoxin(s) in tick saliva. The toxin, which may be different in different species, disrupts nerve synapses in the spinal cord and blocks the neuromuscular junctions. Worldwide, nearly 50 species of hard ticks have been associated with tick paralysis, although any ixodid tick may be capable of producing this syndrome. A tick must be attached to its host for four to six days before symptoms appear. This condition is characterized by an ascending, flaccid paralysis, usually beginning in the legs. Progressive paralysis can lead to respiratory failure and death. Diagnosis simply involves finding the embedded tick, usually at the base of the neck or in the scalp. After tick removal, symptoms resolve within hours or days. However, if paralysis is advanced, recovery can take several weeks. No drugs are available for treatment. *Ixodes ricinus* and *Dermacentor marginatus* commonly cause paralysis in domestic animals in Central Europe and probably in humans as well. *Ixodes gibbosus* has caused paralysis in humans.

Most tick bites are painless, produce only mild local reaction, and frequently go unnoticed. However, dermal necrosis, inflammation or even hypersensitivity reactions may occur within a few days of tick attachment. After tick removal, a reddened nodule may persist for weeks or months. Tick-bite wounds can become infected with *Staphylococcus* and other bacteria causing local cutaneous abscesses. The bite of the cave tick, *Ornithodoros tholozani*, produces deep red, crusted nodules or papules up to 1.5 cm in diameter. Tick toxicosis is a systemic reaction to tick saliva. Tickbite anaphylaxis has rarely been reported, but studies in Australia suggest it is more common and potentially life threatening than tick paralysis. Tick removal and other personal protective measures against ticks are discussed in Appendix F.

Scabies is the most important disease caused by mite infestation, and infestations have been a common feature of military campaigns. During World War I, scabies infestations occurred at a rate of 20 per 1,000 soldiers per year among American forces in Europe. During World War II, nearly 100,000 cases were reported in American troops. Five percent of the residents of London became infested with scabies during the bombing of that city by the German Luftwaffe. During the Falklands War of 1982, scabies became such a problem among Argentine troops that their fighting efficiency was significantly impaired.

Sarcoptes scabiei (family Sarcoptidae) is a parasitic mite that spends its entire life cycle in burrows in the skin of mammals. Mite infestations cause scabies in man and mangle in other animals, including primates, horses, wild and domestic ruminants, pigs, camels, rabbits, and dogs and other carnivores. Populations found on different host species differ physiologically more than morphologically and are referred to as forms (those on man, for instance, are *S. scabiei* form *hominis*). All forms are considered to be the same species, *Sarcoptes scabiei*. Mites from one host species do not establish themselves on another. Humans can become infested with scabies mites from horses or dogs, but such infestations are usually mild and disappear without treatment. *Sarcoptes* mites are common on domestic animals in Central Europe, especially stray dogs, so troops should avoid contact with local animals.

Scabies mites are very small, about 0.2 to 0.4 mm. Both sexes burrow in the horny layer of the skin, but only the female makes permanent winding burrows parallel to the skin surface. Burrowing may proceed at up to five mm per day, and the burrow may extend over a cm in length. The female lays a few eggs in the burrow. The six-legged larvae that hatch from the eggs three to four days after oviposition leave the burrow and move to the hair follicles. Two nymphal stages that precede the adult are also found in the hair follicles. The entire life cycle takes 10 to 14 days. Scabies is transmitted from person to person by close, prolonged personal contact. Transmission is common in dormitories, barracks and medical facilities. Mites die rapidly away from the human body.

Most mite burrows occur in the interdigital and elbow skin, but skin of the scrotum, breasts, knees and buttocks is also affected. The face and scalp are rarely involved. In newly infested persons, a period of three to four weeks usually elapses before sensitization to mites and mite excretions develops. Itching is not experienced during this period, and infestations may progress extensively before being noticed. However, fewer than 20 mites are enough to produce intense itching, particularly at night. The burrows often become secondarily infected with bacteria. In infested persons, an extensive rash can cover areas where there are no mites. In immunocompromised individuals, who do not respond to infestation by itching and scratching, mites can reach very high populations and produce a scaly crusted skin known as Norwegian scabies.

Sarcoptes scabiei is cosmopolitan but infestations have been declining in Central Europe. Scabies is not a reportable disease in most countries; thus, estimated rates of infestation are usually inaccurate. Scabies is usually only reported when large outbreaks occur. Increases in the incidence of scabies appear to occur in 15 to 20 year cycles that are related to fluctuating levels of immunity to *S. scabiei* in the human population. An epidemiological study of scabies infestation in Poland during the period 1966 to 1986 recorded 1,675,213 cases. Incidence peaked in 1968 at 5,881 cases per 100,000 inhabitants and declined to 48 cases per 100,000 inhabitants by 1986. The highest proportion of cases were individual infestations in people under the age of 20. The

highest morbidity occurred in autumn and winter. A study in Czechoslovakia showed a similar epidemiology, with incidence of infestation peaking in the years 1968 to 1970. Incidence of scabies has increased in the war-torn areas of the former Yugoslavia.

Persons of all ages are affected, although in most developing countries infestation is highest in poor communities and in children. Infestation is more common in overcrowded areas with poor hygiene.

Larvae of the mite family Trombiculidae are known variously as chiggers, harvest mites and scrub itch mites and are parasites of mammals and birds. Over 1,500 species have been described and about 30 of these are known to attack humans. Larvae are very small, measuring about 0.25 mm long. Females lay eggs in damp soil. The eggs hatch into six-legged larvae that congregate near the tips of grass and fallen leaves and attach to passing animals that brush against the vegetation. Larvae cluster in the ears of rodents and around the eyes of birds. On humans they most often attach where the clothing is tight, around the waist or genitals. Chiggers do not burrow into the skin as commonly believed, nor do they feed primarily on blood; rather they remain on the skin surface and use digestive fluids to form a feeding tube (stylostome) that enables them to feed on cellular material for several days. Fully fed larvae drop to the ground to continue their complex life cycle. In the nymphal and adult stages, these mites are believed to prey on the eggs and larvae of other arthropods. Most temperate zone chiggers have one annual generation.

Chiggers do not transmit disease in Central Europe but can cause an intense itchy dermatitis leading to pustules and sometimes to secondary infection. Species of chigger mites are common throughout the region. *Neotrombicula autumnalis* is frequently implicated in human infestations in Europe. It is commonly called the harvest mite because the parasitic larvae are active at harvest time in summer and early autumn. It has been responsible for mass outbreaks of dermatitis even in suburban areas and urban parks of Central Europe.

2. Araneae (spiders). More than 35,000 species of spiders have been described worldwide. All spiders, with the exception of the family Uloboridae, are venomous and use their venom to immobilize or kill prey. Most spiders are harmless because their chelicerae cannot penetrate human skin, or they have venom of low toxicity to humans. Only about a dozen species have been responsible for severe systemic envenomization in humans, although as many as 500 may be capable of inflicting significant bites. Those that can bite humans are rarely seen or recovered for identification, so physicians need to be able to recognize signs and symptoms of common venomous spider bites in order to administer appropriate therapy. In Central Europe the widow spiders, *Lactrodectus* spp. (family Theridiidae), and the sac spiders, *Chiracanthium* spp. (family Clubionidae), are responsible for significant local and systemic effects from envenomization.

The brown widow, *L. geometricus*, and the black widow, *L. mactans*, are widespread throughout the region. These are also referred to as hourglass, shoe button, or po-ko-moo spiders. Considerable variation in coloration and markings exists between species and between immatures and adults. Widow spiders are found in various habitats in the wild, especially in protected places, such as crawl spaces under buildings, holes in dirt embankments, piles of rocks, boards, bricks or firewood. Indoors, they prefer dark areas behind or underneath appliances, in deep closets and cabinets. They commonly infest outdoor privies, and preventive medicine personnel should routinely inspect these structures. Widow spiders spin a crude web and usually will not bite unless provoked.

Latrodectus spp. inject a potent neurotoxin when biting. The bite itself is mild and most patients don't remember being bitten. Significant envenomization results in severe systemic symptoms, including painful muscle spasms, a rigid board-like abdomen, and tightness in the chest. Mortality rates from untreated bites have been estimated at 1 to 5%. Most envenomizations respond quickly to sustained intravenous calcium gluconate. Antivenins are commercially available and very effective.

Sac spiders of the genus *Chiracanthium* have a cytolytic venom that produces cutaneous necrosis in its victims, although the necrotizing lesions are usually not as severe as those produced by the bite of *Loxosceles* spp. Some species have neurotoxic components in their venom. Over 150 species of sac spiders have been recorded worldwide.

Chiracanthium punctorium is found in southern and Central Europe and is considered to be Europe's most venomous spider after the *Latrodectus* spp. The consequences of bites include severe local pain, fever, swelling and redness, with a small area of necrosis at the site of the bite.

3. Ceratopogonidae (biting midges, no-see-ums, punkies). The Ceratopogonidae is a large family containing nearly 4,000 species. These extremely small flies can easily pass through window screens and standard mosquito netting, although most species feed outdoors. Their small size is responsible for the moniker "no-see-ums." Many species in this group attack and suck fluids from other insects. Most species that suck vertebrate blood belong to the genera *Culicoides* (1,000 species) or *Leptoconops* (about 80 species). In Central Europe these insects do not transmit human diseases, but they do serve as vectors for several diseases of veterinary importance. Many species of Ceratopogonidae are widespread in the region, but little is known about their biology. Most Central European species of *Culicoides* are zoophilic. *Leptoconops* are more likely to be a major nuisance to man. Blood-sucking species predominately feed and rest outdoors, entering houses in much smaller numbers. Only females suck blood. *Leptoconops* are active during the day; *Culicoides* may be either diurnal or nocturnal. Diurnal species of both genera prefer early morning and late afternoon periods. Despite their small size, they often cause local reactions severe enough to render a military unit operationally

ineffective. In sensitive people bites may blister, exude serum, itch for several days, or be complicated by secondary infections from scratching. Enormous numbers of these tiny flies often emerge from breeding sites, causing intolerable annoyance.

Breeding habits vary widely from species to species. The larvae are primarily aquatic or semiaquatic, occurring in the sand or mud of fresh, salt, or brackish water habitats, notably salt marshes and mangrove swamps. Many species exploit specialized habitats such as tree holes, decaying vegetation, and cattle dung. Most species remain within 500 m of their breeding grounds. Ceratopogonidae are troublesome mainly under calm conditions, and the number of flies declines rapidly with increasing wind speed. In militarily secure areas, encampments should be located in the open, away from breeding sites, to avoid the nuisance caused by these insects.

Larvae are difficult to find, but adults are easily collected while biting and with light traps. Environmental management best controls larval stages, but this may be impractical. Adult control typically includes applying residual insecticides to fly harborages, treating screens and bednets with pyrethroids, and using repellents.

4. Chilopoda (centipedes) and Diplopoda (millipedes). Centipedes in tropical countries can attain considerable size. Members of the genus *Scolopendra* can be over 25 cm long and are capable of inflicting painful bites, with discomfort lasting one to five hours. Species of this genus known to bite man are most likely to be encountered in coastal areas of the Mediterranean. Two puncture wounds at the site of attack characterize the bite. Neurotoxic and hemolytic components of a centipede's venom normally produce only a localized reaction, but generalized symptoms such as vomiting, irregular pulse, dizziness and headache may occur. Most centipede bites are uncomplicated and self-limiting, but secondary infections can occur at the bite site. Centipede bites are rarely fatal to humans.

Centipedes are flattened in appearance and have one pair of legs per body segment. Large species may have over 100 pairs of legs. They are fast-moving, nocturnal predators of small arthropods. During the day, they hide under rocks, boards, bark, stones and leaf litter, but occasionally they find their way into homes, buildings, and tents. Centipedes are not aggressive and seldom bite unless molested. Most centipede bites occur when the victim is sleeping or when putting on clothes in which centipedes have hidden. Troops should be taught to inspect clothing and footwear when living in the field.

Millipedes are similar to centipedes except that they have two pairs of legs per body segment and are rounded or cylindrical instead of flattened. Millipedes are commonly found under stones, in soil and in leaf litter. They are nocturnal and most species feed on decaying organic matter. They are more abundant during the wet season. When

disturbed they coil up into a tight spiral. Millipedes do not bite or sting, but some species secrete defensive body fluids containing quinones and cyanides that discolor and burn the skin. An initial yellowish-brown tanning turns to deep mahogany or purple-brown within a few hours of exposure. Blistering may follow in a day or two. Eye exposure may require medical treatment. A few species from the genera *Spirobolida*, *Spirostreptus*, and *Rhinocrichus* can squirt their secretions a distance of 80 cm or more.

5. Cimicidae (bed bugs). There are over 90 species in the family Cimicidae. Most are associated with birds and/or bats and rarely bite humans. The common bed bug, *Cimex lectularius*, has been associated with humans for centuries and is cosmopolitan in distribution. The tropical bed bug, *Cimex hemipterus*, also feeds on humans and is similar in appearance to *C. lectularius*. It is common in tropical areas of Asia, Africa and Central America. Bed bug infestations are typical of unsanitary conditions, but they can still be found in developed countries. There is little evidence that bed bugs transmit any pathogens. Bites can be very irritating, prone to secondary infection after scratching, and may produce hard swellings or welts. Bed bugs feed at night while their hosts are sleeping but will feed during the day if conditions are favorable. During the day they hide in cracks and crevices, under mattresses, in mattress seams, spaces under baseboards, or loose wallpaper. Chronic exposure to bed bugs can result in insomnia, nervousness and fatigue. Some studies have found a high percentage of asthmatic patients had positive skin reactions to *Cimex* antigen.

Five nymphal instars precede the adult stage. Each nymph must take a bloodmeal in order to molt. Adults live up to one year. Bed bugs take about five minutes to obtain a full bloodmeal. They can survive long periods of time without feeding, reappearing from their hiding places when hosts become available. Bed bugs possess scent glands and emit a characteristic odor that can easily be detected in heavily infested areas. Blood spots on bedding or “bedclothes” and fecal deposits are other signs of infestation.

Infestations of bed bugs in human habitations are uncommon in most areas of Central Europe. In Czechoslovakia the bat bug, *Cimex dissimilis*, has been known to attack man when bat colonies were removed from human dwellings. Bed bugs can be introduced into barracks through infested baggage and belongings. In contingency situations, old dwellings should be surveyed for these and other pests before they are occupied. *Cimex lectularius* is common in poultry houses in many parts of the region and should be avoided by military personnel.

6. Dipterans Causing Myiasis. Myiasis refers to the condition of fly maggots infesting the organs and tissues of people or animals. Worldwide there are three major families of myiasis-producing flies: Oestridae, Calliphoridae and Sarcophagidae. The Oestridae contains about 150 species known as bot flies and warble flies. They are all obligate parasites, primarily on wild or domestic animals. Members of the genera *Cuterebra* and

Dermatobia commonly infest humans in the Americas. The Calliphoridae, known as blow flies, are a large family composed of over 1,000 species. At least 80 species, mostly in the genera *Cochliomyia*, *Chrysomya*, *Calliphora* and *Lucilia*, have been recorded as causing cutaneous myiasis. The family Sarcophagidae, known as flesh flies, contains over 2,000 species, but its only important genus in terms of myiasis is *Wohlfahrtia*.

Myiasis is also classified according to the type of host-parasite relationship, and specific cases of myiasis are clinically defined by the affected organ, e.g., cutaneous, enteric, rectal, aural, urogenital, ocular, etc. Myiasis can be accidental when fly larvae occasionally find their way into the human body. Accidental enteric myiasis occurs from ingesting fly eggs or young maggots on uncooked foods or previously cooked foods that have been subsequently infested. Other cases may occur from the use of contaminated catheters, douching syringes, or other invasive medical equipment in field hospitals. Accidental enteric myiasis is usually a benign event, but larvae may survive temporarily, causing stomach pains, nausea, or vomiting. Numerous fly species in the families Muscidae, Calliphoridae, and Sarcophagidae are involved in accidental enteric myiasis. A common example is the cheese skipper, *Piophilidae casei* (family Piophilidae), which infests cheese, dried meats and fish.

Facultative myiasis occurs when fly larvae infest living tissues opportunistically after feeding on decaying tissues in neglected wounds. Considerable pain and injury may be experienced as fly larvae invade healthy tissues. Facultative myiasis has been common in wounded soldiers throughout military history, and numerous species of Muscidae, Calliphoridae, and Sarcophagidae have been implicated. Species of these families are widespread throughout Central Europe.

Myiasis is obligate when fly larvae must develop in living tissues. This constitutes true parasitism and is essentially a zoonosis. Obligate myiasis is a serious pathology. In humans, obligate myiasis results primarily from fly species that normally parasitize domestic and wild animals. The sheep bot fly, *Oestrus ovis*, is found wherever sheep are raised. Larvae are obligate parasites in the nostrils and frontal sinuses of sheep, goats, camels and horses. Human ocular infestation by *O. ovis* is not uncommon in Central Europe. Several cases occurred in US military personnel during the Persian Gulf War. Female flies are larviparous, depositing larvae while in flight directly into the human eye. Normally, infestations produce a painful but not serious form of conjunctivitis. However, larvae are capable of penetrating to the inner eye, causing serious complications.

Wohlfahrtia magnifica (family Sarcophagidae) is an important obligatory parasite in the wounds and natural orifices of warm-blooded animals, including humans. Female flies deposit over 100 first-stage larvae in wounds or next to body orifices of the host. The

larvae mature in five to seven days before leaving the wound and dropping to the ground where they pupate. Cases of myiasis caused by this species have been reported from Central Europe. This fly commonly infests livestock, particularly sheep. One study in Romania found that 80 to 95% of sheep were infested.

Myiasis is rarely fatal, but troops living in the field during combat are at a high risk of infestation. Good sanitation can prevent most cases of accidental and facultative myiasis. To prevent flies from ovipositing on them, exposed foodstuffs should not be left unattended. Fruits and vegetables should be washed prior to consumption and examined for developing maggots. Extra care should be taken to keep wounds clean and dressed. Avoid sleeping in the nude, especially outdoors during daytime when adult flies are active and likely to oviposit in body orifices. At field facilities, proper waste disposal and fly control can reduce fly populations and the risk of infestation.

The larvae of most species of flies are extremely difficult to identify. Geographic location and type of myiasis are important clues to identity. It is particularly helpful to rear larval specimens so that the adult can be used for identification.

7. Hymenoptera (ants, bees and wasps). Most wasps and some bees are solitary or subsocial insects that use their stings for subduing prey. These species are not usually involved in stinging incidents, and their venom generally causes only slight and temporary pain to humans. The social wasps, bees and ants use their sting primarily as a defensive weapon, and their venom causes intense pain in vertebrates.

The three families of Hymenoptera responsible for most stings in humans are the Vespidae (wasps, hornets, and yellow jackets), the Apidae (honey bees and bumble bees), and the Formicidae (ants). Wasps and ants can retract their stings after use and can sting repeatedly. The honey bee stinging apparatus has barbs that hold it so firmly that the bee's abdomen ruptures when it tries to pull the stinger out of the skin. The bee's poison gland, which is attached to the stinger, will continue injecting venom after separation. Scraping the skin after a bee sting is important to remove the stinger and attached venom sac. Honey bees and social wasps of the family Vespidae account for most stings requiring medical treatment in Central Europe. Wild strains of honey bees may be more aggressive than domesticated populations maintained by bee keepers. Ants can bite, sting and squirt the contents of the poison gland through the tip of their abdomen as defensive secretions. The components of the venom are complex and vary with the species of ant. Formic acid is a common substance discharged as a defensive secretion. Some protein-feeding ants such as the pharaoh ant, *Monomorium pharaonis*, have been incriminated as mechanical vectors of pathogens in hospitals.

Hymenoptera venoms have not been fully characterized but contain complex mixtures of allergenic proteins and peptides as well as vasoactive substances, such as histamine and

norepinephrine. These are responsible for the pain at the sting site, irritation, redness of the skin, and allergic reactions in sensitized individuals. There is no allergic cross-reactivity between honey bee and vespid venoms, although cross-reactivity may exist to some extent between different vespid venoms. Therefore, a person sensitized to one vespid venom could have a serious reaction to the sting of another member of the vespid family.

Reactions to stings may be grouped into two categories, immediate (within two hours) or delayed (more than two hours). Immediate reactions are the most common and are subdivided into local, large local, or systemic allergic reactions. Local reactions are nonallergic responses characterized by erythema, swelling, and transient pain at the sting site that subsides in a few hours. Stings in the mouth or throat may require medical assistance. Multiple stings in a short period of time may cause systemic symptoms such as nausea, malaise and fever. It generally takes 500 or more honey bee stings to kill an adult by the toxic effects of the venom alone. Large local reactions are characterized by painful swelling at least 5 cm in diameter and may involve an entire extremity. Systemic reactions vary from mild urticaria to more severe reactions, including vomiting, dizziness and wheezing. Severe allergic reactions are rare but can result in anaphylactic shock, difficulty in breathing, and death within 30 minutes. Emergency kits should be provided to patients who have experienced anaphylactic reactions to stings. Commercial kits are available that include antihistamine tablets and syringes preloaded with epinephrine. Sensitive individuals should also consider wearing a Medic-Alert tag to alert medical personnel of their allergy in case they lose consciousness. Venom immunotherapy for sensitive individuals will reduce but not eliminate the risk of anaphylactic reactions. The frequency of sting hypersensitivity is probably less than 1% of the population. The prevalence of systemic reactions to Hymenoptera stings was 3.1% of a sample population of the Hellenic Air Force. The study concluded that the prevalence of Hymenoptera allergy and venom sensitization in Greece was high compared to other countries.

Delayed reactions to Hymenoptera envenomization are uncommon but usually present as a large local swelling or, rarely, as systemic syndromes. The cause of delayed reactions is unclear and may not always involve immunologic mechanisms.

Individuals can practice a number of precautions to avoid stinging insects. Avoid wearing brightly colored floral-pattern clothes. Do not go barefoot in fields where bees and wasps may be feeding at ground level. Avoid the use of scented sprays, perfumes, shampoos, suntan lotions, and soaps when working outdoors. Be cautious around rotting fruit, trash containers, and littered picnic grounds, since large numbers of yellow jackets often feed in these areas. Avoid drinking sodas or eating fruits and other sweets outdoors, since bees and yellow jackets are attracted to these items. Bees and wasps are most aggressive around their nests, which should not be disturbed.

8. Lepidoptera (urticating moths and caterpillars). The caterpillars of certain moths possess urticating hairs that can cause dermatitis. The hairs are usually connected to glands that release poison when the hair tips break in human skin. The intensity of the irritation varies with the species of moth, sites and extent of exposure, and the sensitivity of the individual, but usually the symptoms are temporary. Hairs stimulate the release of histamine, and resultant skin rashes last about a week. The irritation is more severe when the hairs reach mucous membranes or the eyes, where they can cause nodular conjunctivitis. When the larva pupates, urticating hairs can also become attached to the cocoon, and later to the adult moth. Hairs readily become airborne. If inhaled, detached caterpillar hairs can cause labored breathing; if ingested, they can cause mouth irritation. The hairs of some species retain their urticating properties long after being shed. Hairs and setae may drop into swimming pools and irritate swimmers.

Scratching and rubbing the affected parts of the body should be avoided to prevent venomous hairs from penetrating deeply into tissues. Running water should be used to wash the hairs out of the lesion. Light application of adhesive tape and stripping it away will remove many of the hairs or spines from the skin. Acute urticarial lesions usually respond to topical corticosteroid lotions and creams, which reduce the inflammatory reaction. Oral histamines help relieve itching and burning sensations.

Larvae of *Thaumetopoea* spp. (processionary moths, Thaumetopoeidae) are common in Europe and the Mediterranean, although contact dermatitis from moth hairs is a limited public health problem in Central Europe. *Thaumetopoea pityocampa* has produced outbreaks of intense dermatitis in the Balkans. The brown-tailed moth, *Euproctis chrysorrhoea* (Family Lymantriidae) has caused large summer outbreaks of allergic dermatitis along the coast of Croatia and on its offshore islands. These moths are readily attracted to artificial light in urban areas. A mature larva of the tussock moth, *E. chrysorrhoea*, may have several million barbed hairs.

9. Meloidae (blister beetles), Oedemeridae (false blister beetles) and Staphylinidae (rove beetles). Blister beetles are moderate-sized (10 to 25 mm in length), soft-bodied insects that produce cantharidin in their body fluids. Cantharidin is a strong vesicant that readily penetrates the skin. Handling or crushing the beetles causes blistering within a few hours of skin contact. There is great variation in individual susceptibility to blistering from cantharidin. Blisters are generally not serious and normally clear within seven to 10 days without scarring. If blister beetles are ingested, cantharidin can cause nausea, diarrhea, vomiting, and abdominal cramps. Blisters that occur on the feet where they will be rubbed may need to be drained and treated with antiseptics. Cantharidin was once regarded as an aphrodisiac, and a European species of blister beetle was popularly known as Spanish-fly. Troops should be warned against using blister beetles for this purpose, since cantharidin is highly toxic when taken orally.

Approximately 1,500 species of Oedemeridae are found worldwide. They are slender, soft-bodied beetles, five to 20 mm in length. The adults of most species feed on pollen, so they are commonly found on flowers. These beetles also contain the vesicant cantharidin. Although there are few references in the medical literature, blister beetle dermatitis caused by oedemerids may be more common and widespread than currently recognized. During a training exercise on the North Island of New Zealand in 1987, 74 of 531 soldiers developed blistering after exposure to *Thelyphassa lineata*. Oedemerids are readily attracted to light.

The Staphylinidae, commonly called rove beetles, is another family that produces a strong vesicating substance that causes blistering. Rove beetles are active insects that run or fly rapidly. When running, they frequently raise the tip of the abdomen, much as scorpions do. They vary in size, but the largest are about 25 mm in length. Some of the larger rove beetles can inflict a painful bite when handled. Many species are small (<five mm) and can get under clothing or in the eyes. Members of the genus *Paederus* are widespread throughout the world. They have a toxin, paederin, that can cause dermatitis, painful conjunctivitis and temporary blindness after eye contact. Normally, rove beetles must be crushed to release the vesicating agent. Like beetles in the family Meloidae, rove beetles are attracted to light and can be a hazard to soldiers at guard posts. Rove beetles often emerge in large numbers after rains and can cause outbreaks of dermatitis. A 1966 outbreak of blistering on Okinawa resulted in 2,000 people seeking medical treatment.

10. Scorpionida (scorpions). These arthropods have a stout cephalothorax, four pairs of legs, a pair of large anterior pedipalps with enlarged claws, and a tail tipped with a bulbous enlargement and a poisonous stinger. Some species carry the tail above the dorsum of the thorax, while others drag it behind. Of over 1,500 described species worldwide, fewer than 25, all in the family Buthidae, possess a venom that is life threatening to humans. Scorpions inject the venom with a stinger on the tip of their abdomen, and some species can inflict a painful pinch with their pedipalps. They feed at night on insects, spiders and other arthropods. During the daytime, scorpions hide beneath stones, logs or bark, loose earth or among manmade objects. In dwellings, scorpions frequently rest in shoes or clothing.

There are few scorpions in Central Europe. The two most widely distributed medically important species are *Buthus occitanus* and *Euscorprius capathicus*. An additional medically important species, the black scorpion, *Androctonus crassicauda*, has been reported from Greece, but this report may be erroneous. A list of scorpions reported from Central Europe appears in Appendix A.5.

Most stings are to the lower extremities or the arms and hands. Among indigenous populations, stings are more often inflicted at night, while scorpions are most actively

hunting for prey. Scorpion stings can occur year-round in countries such as Greece, coastal Albania, and Bosnia and Herzegovina. However, in countries of Central Europe with colder climates, most stings are reported during the warmer months of April to August.

In Albania, Greece, and the countries of the former Yugoslavia (except Slovenia) the sting of *Buthus occitanus* causes localized pain, edema, occasional hospitalization and even death in children. No scorpions of medical importance have been reported from the Czech Republic, Hungary, Poland, the Slovak Republic or Slovenia. However, the movement of refugees within Central Europe may have aided in the dispersal of scorpion species to previously scorpion-free areas.

Scorpions can sting multiple times, and when trapped, as with a person in a sleeping bag, will readily do so, as long as the victim is active. Common places where stings are encountered by military personnel include the boots and under or around piled clothing. Scorpion stings broadly affect nearly all body tissues, and they present a mixture of hemolytic, neurotoxic and cardiotoxic effects. All stings should be considered potentially dangerous. The severity of scorpion stings can be categorized as follows: 1) patients with pain but no systemic findings; 2) those who, in addition to pain, have one or two mild systemic manifestations, such as local muscle spasm, dry mouth, increased salivation, or runny nose; 3) those who have more severe systemic manifestations but no central nervous system manifestation or general paralysis; and 4) those who have severe systemic reactions, including central nervous system involvement, such as confusion, convulsions, and coma, with or without general paralysis. They may also develop uncoordinated eye movements, penile swelling, or cyanosis. The most severe manifestations occur in children, who are more susceptible to the effects of venom because of their small body mass. Those with type 1, 2, or 3 manifestations can be managed by attempting to slow the spread of the venom by applying ice, and supporting the patient with fluids and antihistamines. However, those with type 4 manifestations require intensive medical treatment, especially during the first 24 hours following the sting. Antivenin therapy is important for severe cases. For this treatment to be effective, the stinging scorpion must be captured so it can be properly identified.

To prevent scorpion stings, military personnel should be instructed to empty boots before attempting to put them on, carefully inspect clothing left on the ground before putting it on, and keep sleeping bags tightly rolled when not in use. Also, troops must be cautioned that scorpions can cause painful reactions requiring medical treatment and should never be kept or handled as pets.

11. Simuliidae (black flies, buffalo gnats, turkey gnats). Black flies are small (three to five mm), usually dark, stout-bodied, hump-backed flies with short wings. Despite their appearance, black flies are strong flyers that are capable of dispersing many km from

their breeding sites. Only females suck blood. They can emerge in large numbers and be serious pests of both livestock and humans. Black flies bite during the day and in the open. Some species have a bimodal pattern of activity, with peaks of activity around 0900 h in the morning and 1700 h in the afternoon, but in shaded areas biting is more evenly distributed throughout the day. The arms, legs and face are common sites of attack, and a favorite site is the nape of the neck. Black fly bites may be itchy and slow to heal. Systemic reactions, characterized by wheezing, fever or widespread urticaria, are rare but require medical evaluation and treatment. Numerous species of anthropophilic black flies are distributed throughout Central Europe and have been a significant source of human discomfort.

12. Siphonaptera (fleas). Fleabites can be an immense source of discomfort. The typical fleabite consists of a central spot surrounded by an erythematous ring. There is usually little swelling, but the center may be elevated into a papule. Papular urticaria is seen in persons with chronic exposure to fleabites. In sensitized individuals, a delayed papular reaction with intense itching may require medical treatment.

Some fleas are extremely mobile, jumping as high as 30 cm. Biting often occurs around the ankles when troops walk through flea-infested habitat. Blousing trousers inside boots is essential to provide a barrier, since fleas will crawl under blousing garters. Fleas may be encountered in large numbers shortly after entering an abandoned dwelling, where flea pupae may remain in a quiescent state for long periods of time. The activity of anyone entering such premises will stimulate a mass emergence of hungry fleas. The most common pest fleas encountered in Central Europe are the cosmopolitan cat and dog fleas, *Ctenocephalides felis* and *C. canis*, the Oriental rat flea, *Xenopsylla cheopis*, and the human flea, *Pulex irritans*. A list of ceratophyllid and pulicid species reported from this region appears in Appendix A.4.

13. Tabanidae (horse flies and deer flies). Tabanids are large, stout-bodied flies with well-developed eyes that are often brilliantly colored. More than 4,000 species have been described worldwide. The larvae develop in moist or semiaquatic sites, such as the margins of ponds, salt marshes or damp earth. The immature stages are unknown for most species. Mature larvae migrate from their muddy habitats to drier areas of soil to pupate. In temperate regions the entire life cycle can take two years or more to complete. The larvae of horse flies are carnivorous and cannibalistic, whereas deer fly larvae feed on plant material. Consequently, deer fly populations can reach considerably higher numbers in the same area. Deer flies, about 8 to 15 mm long, are about half the size of horse flies, which range from 20 to 25 mm long. The most common tabanid genera containing man-biting species are *Chrysops* (deer flies) and *Tabanus* and *Haematopota* (horse flies).

Only female tabanids bite and take a blood meal, and nearly all species feed on mammals. Males feed on flower and vegetable juices. Tabanids are diurnal and are most active on warm, sunny days with low wind speeds, especially during the early morning and late afternoon. Adults are powerful flyers with a range of several km. They are very persistent biters, and their painful bites are extremely annoying. Tabanids lacerate the skin with scissor-like mouthparts and ingest the blood that flows into the wound. Some species can consume as much as 200 mg of blood. The puncture in the skin continues to ooze blood after the fly has fed. Tabanid bites often become secondarily infected, and systemic reactions may occur in hypersensitive individuals. The mouthparts and feeding behavior of tabanids are well suited to the mechanical transmission of blood-borne pathogens. Because their bites are painful, tabanids are frequently disturbed while feeding and move readily from host to host. In Central Europe, tabanids are not vectors of human disease but are serious pests of livestock and transmit several diseases of veterinary importance.

Tabanids are difficult to control. Larval control is impractical, and ULV aerosols are generally ineffective against adults. Localized control can be achieved around military encampments using a variety of simple traps. The skin repellent DEET is only moderately effective against these flies.

B. Venomous Snakes of Central Europe

There are six species of venomous snakes in Central Europe, but only three of these are widely distributed (Table 1). The two families of venomous snakes present in the region are Colubridae and Viperidae.

Although most species of the family Colubridae are nonvenomous, there is one venomous species in Central Europe. This species, *Malpolon monspessulanus*, possesses relatively small, grooved fangs in the rear of the upper jaw. In order to envenomate a person, it literally has to be picked up and handled. This snake is rarely encountered, and little is known about the nature of its venom, except that it can generate an allergic response.

Species of Viperidae are commonly known as vipers, adders, or asps. They have heavy, patterned bodies and triangle-shaped heads, sometimes with horns. They possess two relatively long, hollow fangs at the front of the upper jaw. These fangs are erected during a bite, but are folded against the palate when the mouth is shut. Five species of this family occur in Central Europe.

Macrovipera schweizeri, the schweizer's, Milos, or Cyclades blunt-nosed viper, has only been reported from Greece in Central Europe. This is a robust snake with an average length of 0.75 to 1.15 m. It is the largest venomous snake in Europe. The head is broad

and triangular and distinct from the neck. This snake has a series of brown to gray spots on its back, which are sometimes joined together. The snake tends to be almost gray in sandy areas. This species is nocturnal and is very lethargic during the day. Although it appears sluggish even when hunting, it can strike quickly if molested. It occurs in a wide range of habitats, including semi-desert to high hilly areas and mountains up to 2,100 m. In the Greek islands, it is found in rocky river valleys, often near cultivated fields and pastures. It is principally a ground dweller, but it can climb bushes and small trees. The venom of this viper is only moderately toxic, but its bite is considered very dangerous because of the size of the snake and the amount of venom that may be injected. Its bite has killed humans as well as sheep, horses and cattle.

Vipera ammodytes, the sand viper, is widely distributed in Central Europe, with Poland being the only country from which it has not been reported. This is a medium-sized snake, with a length ranging from 0.6 to 0.75 m. This viper appears to have a short horn on the tip of its nose. The head is nearly triangular and distinct from the neck. The body is stout, with a zigzag series of dorsal dark stripes. The overall color is ash gray in males to reddish brown in females. This snake inhabits a variety of areas, from low plains to mountains at 2,500 m. It seeks gravelly, rocky areas with few trees and shrubs. It is mainly a ground dweller but may climb into bushes. This species hibernates from October to April over much of its range. It is sluggish and not aggressive, although it hisses loudly when disturbed. Despite its sluggish behavior, it can strike very quickly. The sand viper has a highly toxic venom and is considered by many authors to be the most venomous snake in Europe. Fortunately, only a small quantity of venom is injected.

Vipera aspis, the asp viper, is found only in Slovenia. This is a small, robust species that attains a length of 0.45 to 0.6 m. The head is triangular and distinct from the neck. The snout is distinctly upturned but lacks a nose-horn. The back of the body appears to have a series of transverse brownish bars, while the overall color of the snake ranges from yellowish brown to gray or light brown. This species can tolerate very cold weather well and remains active in temperatures as low as 5 °C. It can be found in wet mountainous regions, but it is more common in warmer, dry, hilly areas and rocky hillsides at lower elevations. This snake hibernates from October to April. It is a diurnal species in the spring and fall but becomes a nocturnal hunter during hot summer periods. In the summer it remains under the cover of vegetation. Individual snakes do not travel very far and may stay in the same locale for several years. This species is not aggressive and often appears sluggish. It will strike only if harassed. The risk of envenomation is low, and the venom usually produces mild to moderately toxic reactions in humans. However, fatalities have been recorded.

Vipera berus, the common adder, is very widely distributed and present in all countries of Central Europe. This snake has a stout body that is slightly flattened and attains a length of 0.5 to 0.6 m. The head is ovoid in shape and only slightly broadened toward its

rear. There is a distinct series of zigzag marks running down the back of the snake, but the overall appearance of males is of a rather plain gray snake, while females are often brown. This species has the northernmost distribution of any of the European vipers and can tolerate the coldest environment of any of the viper species. It is found in rocky hillsides, woods, moors, and bogs in the northern part of its range. In southern countries, it is restricted to mountainous areas or moist lowlands. It is a good swimmer and can be found in rivers and lakes. It flourishes in areas where there are numerous small, ground-dwelling animals. This adder hibernates in winter and is active primarily from March to September, although it may come out of hibernation for short periods during warm spells. It is a gregarious species, often hibernating in colonies. The common adder is not aggressive and usually freezes when danger is sensed. It bites only when highly alarmed or stepped upon. Its venom is not very toxic.

Vipera ursinii, the meadow viper, is a small, moderately thick viper, with a length ranging from 0.4 to 0.5 m. It is the smallest European viper and is found in southern areas of Central Europe. The center of the back contains a series of dark, zigzag blotches. The overall dorsal surface can range from yellow to greenish or light brown. Completely black specimens have been found in parts of its range, especially in the former Republic of Yugoslavia. This species occurs in dry plains and flatlands with few trees and bushes, although it can also occur in sparse woods, hillsides, and mountainous areas up to 2,700 m. Occasionally it occurs in grasslands and even marshes. It hides in rodent dens and small animal burrows. This species usually hibernates in colonies from November to February. During the spring and fall it is usually diurnal, but during the hot summer months it is a nocturnal hunter, feeding on lizards, grasshoppers and rodents. This snake is docile and seldom bothers humans, but it will bite if continuously disturbed. Its venom is the least toxic of the vipers in Europe, and there are no recorded human fatalities from its bite.

Sources of snake antivenoms are listed in Appendix D. For additional information on snakes and snakebite, contact DPMIAC. Also consult: Management of Snakebite in the Field, by LTC Hamilton, section IX A .

Table 1. Venomous Snakes and their Reported Distribution in Central Europe

Snake Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
COLUBRIDAE													
<i>Malpolon monspessulanus</i>	+	+	+	+		+		+			+		+
VIPERIDAE													
<i>Macrovipera schweizeri</i>						+							
<i>Vipera ammodytes</i>	+	+	+	+	+	+	+	+		+	+	+	+
<i>V. aspis</i>													+
<i>Vipera berus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>V. ursinii</i>	+	+	+	+		+	+	+		+	+		

C. Medical Botany.

1. Plants that Cause Contact Dermatitis.

Plant dermatitis is a problem of enormous magnitude. Categories of dermal injury caused by plants include mechanical injury, immediate or delayed contact sensitivity, contact urticaria, phototoxicity and photoallergy, primary chemical irritation, or some combination of these. Plants causing contact dermatitis in Central Europe are listed in Table 2.

Mechanical injury by splinters, thorns, spines, and sharp leaf edges can produce visual impairment or fungal and bacterial infections at the site of injury. Some dried seeds are hygroscopic and can cause severe discomfort due to swelling of the plant tissues when lodged in the auditory canal or other body cavities.

Members of the *Rhus* group (poison ivy, oak, and sumac) are the most frequent causes of acute allergic contact dermatitis. About 70% of the US population is sensitive to urushiol in the sap of these plants. Any part of the skin surface of a sensitized individual may react upon contact with *Rhus* spp. Urushiol remains active for up to one year and is easily transferred from an object to a person, so anything that touches poison ivy (clothing, tools, animal fur, sleeping bags) can be contaminated with urushiol and cause a skin reaction. Even smoke from burning plants can produce a severe allergic response. Barrier creams have been developed to prevent contact dermatitis in people sensitive to urushiol, but they are only partially effective.

Contact urticaria may result from immunological or nonimmunological host responses, although the latter is more common. Nettles, such as *Urtica* spp., are examples of plants that cause nonimmunological contact urticaria. These plants have hollow stinging hairs that inject a chemical after penetration of the skin. A burning sensation and pruritis occur almost immediately.

A number of cultivated plants of the carrot and rue families sensitize the skin to long-wave ultraviolet light (phytophotodermatitis). Within six to 24 hours of contact with the plant and exposure to sunlight or fluorescent light, the area of contact will selectively burn. In some cases, hyperpigmentation may persist for several months.

Some plants contain primary chemical irritants that produce skin damage resembling that from contact with a corrosive acid. The reaction depends on the potency of the irritant. The most serious reactions involve the eyes. *Daphne* spp. and *Euphorbia* spp. are examples of plants containing chemical irritants.

For additional information on plants causing dermatitis, contact the Armed Forces Medical Intelligence Center, Fort Detrick, MD, (301) 619-7574, DSN: 343-7574; FAX: (301) 619-2409 (DSN = 343).

Table 2. Plants that Cause Contact Dermatitis in Central Europe.

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
<i>Aconitum</i> spp.	+	+		+	+		+	+	+	+	+	+	+
<i>Actaea</i> spp.		+	+	+	+		+	+	+		+	+	+
<i>Bryonia</i> spp.							+						
<i>Croton</i> spp.	+	+	+	+	+		+	+	+	+	+	+	+
<i>Daphne</i> spp.	+		+		+		+		+	+			
<i>Datura</i> spp.	+		+		+		+		+	+			
<i>Euphorbia</i> spp.	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Heracleum</i> spp.	+	+	+		+		+	+	+	+	+	+	+
<i>Polygonatum</i> spp.		+		+				+			+	+	+
<i>Rhus</i> spp. (<i>Toxicodendron</i> spp.)	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Tamus</i> spp.					+		+						

<i>Urtica</i> spp.	+	+	+	+	+		+	+	+	+	+	+	+
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2. Systemic Toxicity from Ingestion of Plants.

Most wild plants contain toxic components, and military personnel must be instructed not to consume local plants unless necessary for survival. Wild plants are difficult to identify, and poisonous plants can easily be mistaken for plants with parts safe to eat. Military personnel will be forced by necessity to consume wild plants during survival operations. To avoid accidental poisoning, they should be thoroughly trained to recognize common edible plants in the region. Local inhabitants may be knowledgeable about poisonous plants in their vicinity.

Many plants have fruiting bodies that appear edible or have attractive parts, such as the castor bean. Some military personnel may be tempted to consume plants because they are used locally for various purposes. Local lore may attribute medicinal qualities, psychotropic or aphrodisiac effects to native plants. Medical personnel and combat commanders must be aware that some troops will be tempted to experiment with native plants. Military personnel should not chew on any part of an unfamiliar plant or use unfamiliar plants for fuel or cooking materials.

In most cases of poisoning, care is usually symptom driven. The age and medical condition of the patient influence toxic response and medical treatment. Special monitoring and specific drug therapy are indicated in some instances. Because life-threatening intoxications are rare, military medical personnel may have little experience in management of plant poisoning. It is inappropriate to assume that the toxicity exhibited by a single member of a genus will apply to all other species of that genus or that all toxic members of a genus will have similar effects. Most toxic plants, regardless of their ultimate effects, induce fluid loss through vomiting and diarrhea. This is important when military personnel are operating in hot, arid areas. Plant toxicity varies with the plant part, maturity, growing conditions, and genetic variation.

TG 196, Guide to Poisonous and Toxic Plants, provides information on toxic plants common in the US that also occur in other regions of the world. It includes a list of state and regional poison control centers. For additional information, contact the Armed Forces Medical Intelligence Center, Fort Detrick, MD, (301) 619-7574, DSN: 343-7574; FAX: (301) 619-2409 (DSN = 343).

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Appendix A.1. Distribution of Mosquitoes in Central Europe (+ = present; ? = uncertain).

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
<i>Aedes aegypti</i>	+	+	?			+		+			?		
<i>Ae. albopictus</i>	+					+							
<i>Ae. annulipes</i>			+		+	+			+	+		+	
<i>Ae. behningi</i>										+		+	
<i>Ae. berlandi</i>						+							
<i>Ae. cantans</i>					+	+			+	+		+	
<i>Ae. caspius</i>			+		+	+	+		+	+		+	
<i>Ae. cataphylla</i>					+				+	+		+	
<i>Ae. cinereus cinereus</i>			+		+				+	+		+	
<i>Ae. cinereus rossicus</i>					+				+			+	
<i>Ae. communis</i>			+		+				+	+		+	
<i>Ae. cretinus</i>						+							
<i>Ae. cyprius</i>									+			+	
<i>Ae. detritus</i>						+			+	+		+	
<i>Ae. diantaeus</i>					+				+			+	
<i>Ae. dorsalis</i>					+	+			+	+		+	
<i>Ae. duplex</i>										+			
<i>Ae. echinus</i>			+			+							
<i>Ae. esoensis</i>										?		+	
<i>Ae. excrucians</i>			+		+				+	+		+	

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
<i>Ae. flavescens</i>					+				+	+		+	
<i>Ae. geminus</i>										+		+	
<i>Ae. geniculatus</i>			+		+	+			+	+		+	

A.1. Continued

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
<i>Ae. hungaricus</i>												+	
<i>Ae. intrudens</i>					+				+	+		+	
<i>Ae. lepidonotus</i>						+							
<i>Ae. leucomelas</i>		+			+				+	+		+	
<i>Ae. mariae</i>						+				?			
<i>Ae. nigrinus</i>									+	?		+	
<i>Ae. nigripes</i>									+				
<i>Ae. pulchritarsis</i>			+		+	+				+		+	
<i>Ae. pullatus</i>			+		+					+		+	
<i>Ae. punctor</i>			+		+				+	+		+	
<i>Ae. refiki</i>					+	+				+		+	
<i>Ae. riparius</i>				+	+				+	+			
<i>Ae. rossicus</i>							+						
<i>Ae. rusticus</i>			+		+	+						+	
<i>Ae. sticticus</i>			+		+				+	+	+	+	
<i>Ae. vexans</i>			+	+	+	+	+		+	+	+	+	

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
<i>Ae. zammitii</i>						+							
<i>Anopheles algeriensis</i>		+	+			+		+			+		
<i>An. atroparvus</i>			+	+	+	+			+	+	+	+	+
<i>An. cinereus hispaniola</i>			+			+						+	
<i>An. claviger</i>	+	+	+	+	+	+			+	+	+	+	+
<i>An. hyrcanus</i>			+	+		+		+		+			
<i>An. labranchiaie</i>		+	+	+	+	+			?	+			

A.1. Continued

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
<i>An. maculipennis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>An. marteri marteri</i>			+			+							
<i>An. marteri sogdianus</i>						+							
<i>An. melanoon</i>	+	+	+	?		+		+	?		+		
<i>An. messeae</i>		+	+	+	+	+		+	+	+	+	+	+
<i>An. petragrani</i>						+							
<i>An. plumbeus</i>	+	+	+	+	+	+			+	+	+	+	+

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
<i>An. pseudopictus</i>						+				+			
<i>An. sacharovi</i>	?	+				+		+		+	+		?
<i>An. sergenti</i>						+							
<i>An. superpictus</i>	+	+	+			+		+			+		
<i>Coquillettidia buxtoni</i>						?				+			
<i>Cq. richiardii</i>			+		+	+	+		+	+	+	+	
<i>Culex apicalis</i>			+										
<i>Cx. hortensis</i>			+		+	+				+		+	
<i>Cx. impudicus</i>						?				?			
<i>Cx. laticinctus</i>						+							
<i>Cx. martinii</i>		+			+	?				+		?	
<i>Cx. mimeticus</i>			+			+				?			
<i>Cx. modestus</i>					+	+	+		+	+			
<i>Cx. perexiguus</i>						+							
<i>Cx. pipiens</i>			+	+	+	+	+		+	+	+	+	
<i>Cx. pusillus</i>						+							
<i>Cx. territans</i>					+	+			+	+		+	+
<i>Cx. theileri</i>			+			+				+		+	
<i>Cx. torrentium</i>					+	?			+	+		+	
<i>Cx. univittatus</i>			+										
<i>Culiseta alaskaensis</i>					+				+	+		+	

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
<i>Cs. annulata</i>			+		+	+	+		+	+	+	+	
<i>Cs. fumipennis</i>			+			+				+			
<i>Cs. glaphyroptera</i>			+		+	?				+		+	
<i>Cs. longiareolata</i>			+			+				+		+	
<i>Cs. morsitans</i>					+	+			+	+		+	
<i>Cs. silvestris ochroptera</i>					+				+	+		+	
<i>Cs. subochrea</i>					+	+			+	+		+	
<i>Orthopodomyia pulchripalpis</i>			+			+				+			
<i>Uranotaenia unguiculata</i>			+		+	+				+	+		

Appendix A.2. Distribution of Sand Flies in Central Europe (+ = present; ? = uncertain).

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
<i>Phlebotomus alexandrei</i>	+		+			+				+			
<i>P. balcanicus</i>	+	+	+	+		+	+	+		+	+		?
<i>P. caucasicus</i>			+			+		+		?			
<i>P. jacusieli</i>	+	?				+							
<i>P. longiductus</i>			+	+			+			+	?		
<i>P. major</i>	+	+	+	+		+		+		+	+		+
<i>P. mascittii</i>	+		?			+							+
<i>P. neglectus</i>	+	+		+		+		+			+		+
<i>P. papatasi</i>	+	+	+	+		+	+	+		+	+		+
<i>P. perfliewi</i>	+	+	+	+		+	+	+		+	+		+
<i>P. perniciosus</i>	+	+	+	+		+		+		+	+		+
<i>P. sergenti</i>	+	+	+	+		+	?	+		+	+		+
<i>P. simici</i>	+	+		+		+		+		+	+		+
<i>P. simulus</i>	+	+	+	+		+		+		+	+		+
<i>P. syriacus</i>						+							
<i>P. tobbi</i>	+	+		+		+					+		+

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
<i>Phlebotomus alexandrei</i>	+		+			+				+			
<i>P. balcanicus</i>	+	+	+	+		+	+	+		+	+		?
<i>P. caucasicus</i>			+			+		+		?			
<i>P. jacusieli</i>	+	?				+							
<i>P. longiductus</i>			+	+			+			+	?		
<i>P. major</i>	+	+	+	+		+		+		+	+		+
<i>P. mascittii</i>	+		?			+							+
<i>P. neglectus</i>	+	+		+		+		+			+		+
<i>P. papatasi</i>	+	+	+	+		+	+	+		+	+		+
<i>P. perfiliewi</i>	+	+	+	+		+	+	+		+	+		+
<i>P. perniciosus</i>	+	+	+	+		+		+		+	+		+
<i>P. sergenti</i>	+	+	+	+		+	?	+		+	+		+
<i>P. simici</i>	+	+		+		+		+		+	+		+
<i>P. simulus</i>	+	+	+	+		+		+		+	+		+
<i>P. syricus</i>						+							
<i>Sergentomyia dentata</i>				+		+		+		+	+		+
<i>S. minuta</i>	+			+		+		+		+	+		+

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
<i>Phlebotomus alexandrei</i>	+		+			+				+			
<i>P. balcanicus</i>	+	+	+	+		+	+	+		+	+		?
<i>P. caucasicus</i>			+			+		+		?			
<i>P. jacusieli</i>	+	?				+							
<i>P. longiductus</i>			+	+			+			+	?		
<i>P. major</i>	+	+	+	+		+		+		+	+		+
<i>P. mascittii</i>	+		?			+							+
<i>P. neglectus</i>	+	+		+		+		+			+		+
<i>P. papatasi</i>	+	+	+	+		+	+	+		+	+		+
<i>P. perfiliewi</i>	+	+	+	+		+	+	+		+	+		+
<i>P. perniciosus</i>	+	+	+	+		+		+		+	+		+
<i>P. sergenti</i>	+	+	+	+		+	?	+		+	+		+
<i>P. simici</i>	+	+		+		+		+		+	+		+
<i>P. simulus</i>	+	+	+	+		+		+		+	+		+
<i>P. syricus</i>						+							
<i>S. theodori</i>						+							

Appendix A.3. Distribution of Ticks in Central Europe (+ = present; ? = uncertain).

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
ARGASIDAE													
<i>Argas persicus</i>		+						+		+	+		
<i>A. polonicus</i>									+				
<i>A. reflexus</i>								+		+			
<i>A. vespertilionis</i>								+					
<i>Ornithodoros lahorensis</i>		+					+			+			
<i>O. peusi</i>						+							
IXODIDAE													
<i>Boophilus annulatus</i>		+	+		+	+		+		+	+		
<i>D. marginatus</i>			+	+	+	+				+	+		
<i>D. niveus</i>	?	+	?			?		+		+	?		
<i>D. reticulatus</i>			+	+				+	+	+	+	+	
<i>Haemaphysalis concinna</i>											+		
<i>H. erinacei</i>							+						
<i>H. e. taurica</i>		+											
<i>H. inermis</i>	?	+	+	+	+	+		+	+	+	+	+	
<i>H. parva</i>					+								
<i>H. punctata</i>		+	+	+	+	+		+		+	+	+	+
<i>H. sulcata</i>			+	+		+					+		
<i>Hyalomma aegyptium</i>		+	+								+		
<i>H. detritum</i>	?	+	?	+				+			+		
<i>H. marginatum marginatum</i>	+	+	+	+	?	+		+			+		+
<i>Ixodes canisuga</i>											+		
<i>I. gibbosus</i>	+	+	+			+					+		

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
<i>I. hexagonus</i>	?	+		+		+		+			+	+	+
<i>I. persulcatus</i>					+		?		+	+		+	
<i>I. ricinus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>I. trianguliceps</i>		+	+	+	+			+			+	+	+
<i>Rhipicephalus bursa</i>	?	+	+	+		+		?		?	+		
<i>R. rossicus</i>			+						+	+			
<i>R. sanguineus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+

Appendix A.4. Distribution of Fleas in Central Europe.

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
CERATOPHYLLIDAE													
<i>Amalaraeus arvicolae</i>		+	+	+	+		+	+	+	+	+	+	
<i>A. penicilliger</i>		+	+	+	+		+	+	+	+	+	+	
<i>Callopsylla c. caspia</i>			+										
<i>C. orneacus waterstoni</i>					+							+	
<i>Ceratophyllus c. affinus</i>					+		+					+	
<i>C. c. delichoni</i>					+							+	
<i>C. c. enefdeae</i>		+		+				+			+		
<i>C. c. farreni</i>					+	+	+		+			+	
<i>C. c. fringillae</i>		+	+	+	+	+	+	+	+		+	+	
<i>C. c. gallinae</i>		+		+	+		+	+	+	+	+	+	
<i>C. c. hirundinis</i>		+	+	+		+	+	+	+	+	+		
<i>C. c. pullatus</i>							+			+			
<i>C. c. rossittensis</i>					+	+	+		+			+	
<i>C. c. rusticus</i>		+	+	+	+	+	+	+	+	+	+	+	
<i>C. c. styx</i>		+		+	+		+	+	+		+	+	
<i>C. c. tribulus</i>							+						

<i>C. c. vagabundus</i>					+							+	
<i>C. emmareus borealis</i>					+	+	+		+	+		+	
<i>C. e. columbae</i>		+		+	+		+	+	+		+	+	
<i>C. e. garei</i>		+		+	+		+	+	+		+	+	
<i>C. e. spinosus</i>					+				+			+	
<i>C. monopsyllus sciurorum</i>		+	+	+	+	+	+	+	+	+	+	+	
<i>C. rosickyiana lunatus</i>					+				+			+	

A.4. Continued

Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
<i>Citellophylus martinoi</i>		+		+	+		+	+		+	+	+	
<i>C. simplex</i>			+		+		+			+		+	
<i>Dasypsyllus d. gallinulae</i>		+		+	+	+	+	+	+	+	+	+	
<i>Megaaabothris m. walkeri</i>					+		+		+	+		+	
<i>M. gebiella rectangulatus</i>					+		+		+			+	
<i>M. g. turbidus</i>		+	+	+	+		+	+	+	+	+	+	
<i>Myoxopsylla m. lavarani</i>		+		+	+			+			+	+	
<i>M. miriampsylla jordani</i>			+										
<i>Nosopsyllus n. consimilis</i>			+		+				+	+		+	
<i>N. n. durii</i>						+							
<i>N. n. fasciatus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>N. n. londiniensis</i>					+							+	
<i>N. n. mokrzecky</i>			+		+	+				+		+	

<i>Oropsylla o. silantiewi</i>					+							+	
<i>Paraceras melis</i>		+		+	+		+	+	+	+	+	+	
<i>Tarsopsylla octodecimdentata</i>		+		+	+	+	+	+	+	+	+	+	
PULICIDAE													
<i>Ctenocephalides canis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>C. felis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Pulex irritans</i>	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Xenopsylla cheopis</i>	+	+	+	+	+	+	+	+	+	+	+	+	+

Appendix A.5. Distribution of Scorpions in Central Europe (+ = present; ? = uncertain).

Scorpion Species	ALB	BIH	BGR	HRV	CZE	GRC	HUN	MKD	POL	ROM	SER	SVK	SVN
Buthidae													
<i>Androctonus bicolor</i>						+							
<i>Androctonus crassicauda</i>						?							
<i>Buthus occitanus</i>	+	+	?	+		+		+			+		
<i>Mesobuthus gibbosus</i>	?					+		?		?	+		
Euscorpiidae													
<i>Euscorpius flavicaudis</i>						+							
<i>Euscorpius capathicus</i>	+	+	+	+		+							
<i>Euscorpius germanus</i>		+	+	?		+		+		+	+		+
<i>Euscorpius italicus</i>	+	+	?	?		+		?			?		
<i>Euscorpius</i>						+							
Iuridae													
<i>Iurus dufourei</i>						+							
<i>Panaiurus nordmanni</i>						+							

Appendix B. Vector Ecology Profiles of Tick Vectors in Central Europe.

Species	Geographic Distribution	Potential Hosts	Disease Transmission	Bionomics/Habitat
<i>Boophilus annulatus</i>	Bulgaria, Greece & Serbia.	Adults & immatures feed on cattle, sheep, rarely horses & man.	A minor CCHF vector.	A 1-host tick. All stages of the life cycle are normally spent on cattle. Females lay eggs one month after feeding and mating. Life cycle <1 year.
<i>Dermacentor marginatus</i>	Reported from Bulgaria, Croatia, Greece & Serbia. Probably occurs in other countries.	Adults feed on sheep, cattle, dogs, deer & humans. Immatures feed on rodents, hares, foxes & shrews.	Secondary vector of CCHF, TBE, & Lyme disease. Good vector of spotted fever group & Bhanja virus.	A 3-host tick. Inhabits a wide range of biotopes such as shrubby growth, forests and steppes. Resists desiccation. May diapause on its host. Lays large number of eggs – up to 6,200.
<i>Dermacentor reticulatus</i>	Croatia, Poland, Serbia & Slovakia.	Adults feed on bear, cattle, sheep & dogs. Immatures feed on mice, voles & hedgehogs.	Vectors TBE.	A 3-host tick that occurs along rivers, in meadows & forests. Life cycle usually takes 1 year. Overwinters primarily as adults .
<i>Haemaphysalis concinna</i>	Slovakia.	Adults feed on deer and livestock, especially cattle, sheep & goats. Immatures feed on hedgehogs, hares and birds.	Zoonotic TBE vector. Secondary Lyme disease vector. Transovarial transmission of TBE virus occurs.	A 3-host tick. Inhabits meadows next to woods, marshy areas & streamsides. Engorgement is slow, taking up to 9 days for females. Larvae & nymphs may diapause. Life cycle takes 1-3 years.

Appendix B. Continued.

Species	Geographic Distribution	Potential Hosts	Disease Transmission	Bionomics/Habitat
<i>Haemaphysalis inermis</i>	Bulgaria, Czech Republic, Greece, Romania, Serbia & Slovakia. Possibly other former Yugoslav republics.	Adults feed on deer, goats, cattle & foxes. Immatures feed on hedgehogs, shrews & other small rodents.	Zoonotic TBE	A large 3-host tick. Larvae feed only a few hours. Adults feed for several days but often produce only about 200 eggs.
<i>Hyalomma m. marginatum</i>	Bulgaria, Greece & Slovakia.	Adults feed on sheep, goats, cattle, dogs & sometimes humans. Immatures feed on rodents, hares & birds.	Primary vector of CCHF. Transovarial transmission occurs.	A 3-host tick. Inhabits a wide variety of habitats & is common in cattle pastures or feedlots. Nymphs feed on host's ears. This species is often active in winter months. Aggressive host-seeker; resistant to climatic extremes and aridity.
<i>Haemaphysalis punctata</i>	Bulgaria, Greece, the Czech Republic, Slovakia & Serbia.	Adults feed on sheep, cattle, goats, dogs, deer & humans. Immatures feed on birds, hares and voles.	Transmits TBE, CCHF & Lyme disease. Also vectors Bhanja virus. Transmits TBE & CCHF transovarially.	A 3-host tick. Inhabits shrubby growth, pastures & forests in submediterranean biotopes. Attaches at neck or groin areas of hosts.
<i>Haemaphysalis sulcata</i>	Bulgaria, Croatia, Greece & Serbia.	Adults feed on goats, sheep & deer. Immatures feed on hares, rodents and small lizards.	Bhanja virus.	A 3-host tick that inhabits scrubby oak, beech/pine forests in mountain & high plateaus. Adults emerge in autumn & feed 10-13 days. Life cycle takes 1 year.

Appendix B. Continued.

Species	Geographic Distribution	Potential Hosts	Disease Transmission	Bionomics/Habitat
<i>Ixodes hexagonus</i>	Greece, Serbia, Slovenia, probably Bosnia & Croatia.	Adults & immatures feed on hedgehogs, martens, feral cats, dogs, cattle & badgers.	Zoonotic TBE vector. Transstadial transmission occurs.	A large 3-host tick that lives in lowlands and hilly areas. Has a rapid life cycle that can be completed in 4 months to 1 year.
<i>Ixodes ricinus</i>	Probably all countries of Central Europe.	Adults feed on sheep, cattle, deer, foxes & man. Immatures feed on rodents, hares, hedgehogs, foxes, dogs & man.	Principal vector of Lyme disease. Good vector of TBE. Rarely vectors CCHF. Transovarial transmission of virus occurs.	A 3-host tick. Inhabits moist, dense, oak/hornbeam forests. Poorly adapted to desiccation. Life cycle requires 2-4 years. Females lay up to 2700 eggs. All stages can overwinter.
<i>Ixodes trianguliceps</i>	Bosnia, Bulgaria, Czech Republic, Croatia, Macedonia, Serbia, Slovakia & Slovenia.	Adults & immatures feed on moles, voles & shrews.	Zoonotic TBE vector.	A 3-host tick that lives in forested mountains or grassy hills, often along coasts. A cold-resistant tick that usually completes life cycle in 1 year.

<i>Rhipicephalus bursa</i>	Bulgaria, Greece & Serbia.	Adults feed on swine, cattle, sheep, rarely horses & dogs. Immatures feed on hares, cattle & sheep.	Secondary vector of Lyme disease. A secondary zoonotic CCHF vector.	A 2-host tick. H overwinter. May not found during
<i>Rhipicephalus sanguineus</i>	Throughout Central Europe.	Adults & immatures feed on dogs, cattle, horses, sheep, & sometimes man.	Vectors spotted fever group; possible vector of CCHF.	A 3-host tick. Q Adults attach on neck. Immatures prefer neck. Eggs are la

Appendix C Pesticide Resistance in Central Europe

Vector-borne diseases are an increasing cause of death and suffering in many areas of the world. Efforts to control these diseases have been founded on the use of chemical pesticides. However, the spread of resistance among arthropods has rendered many pesticides ineffective, while few substitute pesticides are being developed. Resistance has been reported to every class of insecticides, including microbial agents and insect growth regulators.

Resistance is formally defined by the WHO as "the development of an ability in a strain of some organism to tolerate doses of a toxicant that would prove fatal to a majority of individuals in a normal population of the same species." Resistance has a genetic basis and is the result of a change in the genetic composition of a population as a direct result of the selection effects of the pesticide.

Early detection and monitoring are vital to resistance management. Historically, standardized methods, test kits and insecticides were provided by WHO. The simplest method of detecting resistance is the diagnostic dose test. The diagnostic dose is a predetermined insecticide dose known to be lethal to a high proportion of susceptible individuals, but that a high proportion of resistant individuals can tolerate. A list of recommended diagnostic doses of many insecticides for a number of arthropod vectors is available from WHO. For terrestrial and/or adult stages, the insecticide is either applied topically or insects are exposed to a surface treated with insecticide. For aquatic stages, insecticide is added to water at given concentrations.

New approaches use rapid biochemical tests to detect resistance and determine resistance mechanisms. These methods permit multiple assays of a single specimen. Worldwide application of biochemical assays will require production of standardized kits similar to the insecticide bioassay kits supplied by WHO. The choice of method to test for

resistance is of great importance in order to determine resistance mechanisms. Consult TG 189, Procedures for the Diagnostic Dose Resistance Test Kits for Mosquitoes, Body Lice, and Beetle Pests of Stored Products. To obtain test kits and additional recommendations for resistance testing contact:

USACHPPM/Entomological Sciences Programs
5158 Blackhawk Road
Aberdeen Proving Ground, MD 21010-5422
Tel: (410) 436-3613
DSN 584-3613, FAX (410) 436-2037

Pesticide resistance can be classified into two broad categories: physiological and behavioral. There are many mechanisms of physiological resistance, including reduced penetration of insecticides through the cuticle, presence of enzymes that detoxify the insecticide, and reduced sensitivity of the target site of the insecticide. Physiological resistance can confer cross-resistance to structurally related insecticides of the same chemical class or related classes. Some vector populations have acquired several resistance mechanisms providing multiple resistance to a variety of insecticide classes. Many vector control programs have reached a stage where resistance is so great that few chemical alternatives are available.

In recent years, synthetic pyrethroids have replaced widely used classes of insecticides such as organophosphates, carbamates, and chlorinated hydrocarbons. These pyrethroids have shown great promise for vector control due to their low mammalian toxicity and ability to quickly immobilize and kill arthropods at low dosages. Unfortunately, resistance has been detected in several medically important arthropods. An issue of concern in vector control is whether DDT resistance confers cross-resistance to pyrethroids as a result of similar resistance mechanisms. Increasing pyrethroid resistance is of particular concern to the US military because of the widespread use of permethrin and other pyrethroids in BDUs, bednets, and vector control programs. Studies indicate that resistance appears rapidly in areas where treated bednets are used to control mosquitoes.

Changes in behavior that result in reduced contact with an insecticide include a reduced tendency to enter treated areas or an increased tendency to move away from a surface treated with insecticide once contact is made. These are population-based changes in a species' genetics resulting from the selection pressure of insecticide use. Avoidance behavior is widespread but poorly understood. Some form of behavioral avoidance has been documented for virtually every major vector species. Methods to detect and determine behavioral resistance have not been standardized and are difficult to interpret.

Pesticide resistance will be an increasing problem for vector control personnel. More than 90% of all pesticides are used for agricultural purposes. Insecticide resistance in at least 17 species of mosquitoes in various countries has occurred because of indirect selection pressure by agricultural pesticides. The development of organophosphate and carbamate resistance in *Anopheles sacharovi*, *An. hyrcanus* and *An. maculipennis* in the Chukurova plain and the northern area around Osmanjik in Turkey has been attributed to the use of chemicals for agricultural pest control.

Innumerable genetic, biological and operational factors influence the development of insecticide resistance. A pesticide use strategy that will prevent the evolution of resistance has not been developed. Tactics to manage or delay the development of resistance include: 1) using nonchemical methods of control as much as possible, 2) varying the dose or frequency of pesticide application, 3) using local rather than area-wide application, 4) applying treatments locally only during outbreaks of vector-borne diseases, 5) using less persistent pesticides, 6) treating only certain life stages of the vector, 7) using mixtures of pesticides with different modes of action, 8) using improved pesticide formulations, 9) rotating pesticides having different modes of action, and 10) using synergists.

Reports of resistance must be interpreted carefully. Many reports of resistance for a vector species are based on single data sets from a single point within a country and may be years if not decades old. Resistant populations tend to revert to susceptible status once insecticide selection pressure has been removed. Isolated reports of resistance, although recent, may indicate local resistance that has not become widespread. Vector control personnel frequently assume that resistance in a particular species occurs throughout their control area but, in reality, insecticide resistance is focal. The length of time an insecticide has been used at a location may not be helpful in predicting the presence of resistance. Vectors in some countries have never developed resistance to DDT, despite decades of use in malaria control. Only appropriate resistance monitoring can guide the vector control specialist in the selection of a suitable insecticide.

Table 3. Specific Reports of Pesticide Resistance in Central Europe.

Country	Species/Stage	Insecticide	Location	Date of Test
Czech Republic	<i>Pediculus humanus capitus</i>	bioallethrin, permethrin & phenothrin	Danube Plain & Dobrudja	1992
Czech Republic	<i>Musca domestica</i> adults	bendiocarb, dimethoate, DDT, fenitrothion, propoxur, trichlorfon	multiple locations	1976-1980
Hungary	<i>M. domestica</i> adults & larvae	bioresmethrin, cypermethrin, DDT, deltamethrin, dioxacarb, lindane, malathion, methoxychlor, permethrin, pyrethrin, trichlorfon	multiple locations	1990
Hungary	<i>M. domestica</i> adults	cypermethrin, deltamethrin, permethrin, tetramethrin	multiple locations	1983-1985
Hungary	<i>M. domestica</i> adults	DDT, dichlorvos, fenitrothion, trichlorfon	multiple locations	1983-1985
Poland	<i>M. domestica</i> adults	permethrin	multiple locations	1985
Romania	<i>M. domesica</i> adults	trichlorfon	Timisoara	1996
Romania	<i>Anopheles messeae</i> adults	DDT	15 localities in the Danube Plain & Dobrudja	1981-1983
Slovakia	<i>M. domesica</i> adults	permethrin	Kosice	1994

Slovakia	<i>M. domesica</i> adults	organophosphates	Kosice	1991-1992
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Hungary

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Poland

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Nosec, I., A. Cristescu, A. Enescu, V. Tacu, I. Giurcă and G. Cristodorescu. 1978. [Studies of the sensitivity to the usual domestic insecticides of the *Anopheles maculipennis* group and *Musca domestica*, *Cimex lectularius* and *Blattella germanica*.] Bacteriol. Virusol. Parazitol. Epidemiol. 23: 183-188.

Slovak Republic

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* Only papers published in the 25 years prior to preparation of this document are included. Most resistance studies in Central Europe were conducted during malaria control programs from the 1960s through the 1970s. Many of the articles included contain tests on insect populations that were found to be susceptible or contain general discussions about pesticide resistance in Central Europe.

Appendix D **Sources of Snake Antivenoms**

1	Perusahaan Negara Biofarms 9, Jalan Pasteur Bandung, Indonesia
2	Behring Institut, Behringwerke AG, D3550 Marburg (Lahn), Postfach 167, Germany. Telephone: (06421) 39-0. Telefax: (06421) 660064. Telex: 482320-02
3	Institute of Epidemiology and Microbiology, Sofia, Bulgaria
4	Shanghai Vaccine and Serum Institute, 1262 Yang An Road (W), Shanghai, PRC
5	Commonwealth Serum Laboratories, 45 Poplar Road, Parkville, Victoria 3052, Australia Telegram: "SERUMS," Melbourne Telex: AA32789, Telephone: 387-1066
6	Foreign Trade Company, Ltd., Kodandaka, 46 Prague 10, Czech Republic
7	Fitzsimmons Snake Park, Box 1, Snell Park, Durban, South Africa
8	Haffkine Bio-pharmaceutical Corporation, Ltd., Parel, Bombay, India
9	Chiba Serum Institute, 2-6-1 Konodai, Ichikawa, Chiba Prefecture, Japan
10	Institut d'État des Serums et Vaccins Razi, P.O. Box 656, Tehran, Iran
11	Central Research Institute, Kasauli (Simia Hills), (H.P.) India
12	Kitasato Institute, 5-9-1 Shirokane, Minato-ku, Tokyo, Japan
13	The Chemo-Sero Therapeutic Research Institute, Kumamoto, 860 Kyushu, Japan
14	National Institute of Health, Biological Production Division, Islamabad, Pakistan. Telex: 5811-NAIB-PK, Telephone: 820797, 827761
15	Research Institute For Microbial Diseases, Osaka University, 3-1 Yamadoaka, Suite 565, Osaka, Japan, Telephone: (06) 877-5121
16	Institut Pasteur Production, 3 Boulevard Raymond Poincaré, 92430-Mames la Coquette, France. Telephone: (1) 47.41.79.22, Telex: PASTVAC206464F
17	Institut Pasteur d'Algérie Docteur Laveran, Algiers, Algeria
18	Industrial and Pharmaceutical Corporation, Rangoon, Burma
19	Rogoff Medical Research Institute, Beilinson Medical Center, Tel-Aviv, Israel
20	South African Institute for Medical Research, P.O. Box 1036, Johannesburg 2000, Republic of South Africa. Telegraph: "BACTERIA", Telephone: 724-1781
21	Instituto Sieroterapica e Vaccinogeno Toscano "Sclavo", Via Fiorentina 1, 53100 Siena, Italy.
22	National Institute of Preventive Medicine, 161 Kun-Yang St., Nan-Kang, Taipei, Taiwan

23	Takeda Chemical Industries, Ltd., Osaka, Japan
24	Research Institute of Vaccine and Serum, Ministry of Public Health U.I. Kafanova, 93 Tashkent, USSR
25	Red Cross Society, Queen Saovabha Memorial Institute, Rama 4 Road, Bangkok, Thailand
26	Twyford Pharmaceutical Services Deutschland, GmbH, Postfach 2108 05, D-6700 Ludwigshafen am Rhein, Germany
27	Institute of Immunology, Rockefellerova 2, Zagreb, Yugoslavia

Appendix E
Selected List of Taxonomic Papers and Identification Keys*

Centipedes and Millipedes

- Kaczmarek, J. 1980. [Centipedes. Chilopoda.] Katalog Fauny Polski No. 36, 43pp.
- Kos, I. 1996. A review of centipedes (Chilopoda, Myriopoda) of Croatia. *Natura Croatica* 5: 145-154.
- Mauries, J.P., S.I. Golovatch and P. Stoev. 1997. The millipedes of Albania: recent data, new taxa; systematical, nomenclatural and faunistical review. *Zoosystema* 19: 255-292.
- Zapparoli, M. 1994. [Taxonomic and faunistic notes on centipedes from Greece (Chilopoda).] *Fragmenta Entomologica* 26: 11-66.

Ceratopogonidae

- Orszagh, I. 1976. The genus *Culicoides* Latr., 1809 (Diptera, Ceratopogonidae). *Acta Fac. Rerum. Nat. Univ. Comenianae Zool. Bratislava* 21: 1-89.*
- Szadzieweli, R. 1991. [Haematophagus biting midges of the genus *Culicoides* (Diptera, Ceratopogonidae) from Poland.] *Wiad. Prazytol., Wroclaw* 37: 53-56.

Cimicidae

- Jablonska, J. 1964. [The species of the family Cimicidae occurring in Poland.] *Pol. Pismo Entomol., Lemberg, Breslau* 34: 185-187.

Culicidae

- Darsie, R. and A. Samanidou-Voyadjoglou. 1997. Keys for the identification of the mosquitoes of Greece. *J. Amer. Mosq. Cont. Assoc.* 13: 247-254.*
- Gaffigan, T.V. and R.A. Ward. 1985. Index to the second supplement to "A catalog of the mosquitoes of the world (Diptera: Culicidae)." *Mosq. Syst.* 17: 52-63.

- Knight, K.L. 1978. Supplement to "A catalog of the mosquitoes of the world (Diptera: Culicidae)." Thomas Say Foundation, Entomological Society of America, Vol. 6, 107 pp.
- Knight, K.L. and A. Stone. 1977. A catalog of the mosquitoes of the world (Diptera: Culicidae). 2nd ed. Thomas Say Foundation, Entomological Society of America, Vol. 6, 611 pp.
- Maslov, A.V. 1989. Bloodsucking Mosquitoes of the Subtribe Culesitina (Diptera:Culicidae) in World Fauna. Amarind Pub. Co. Pvt. Ltd., New Delhi, 248 pp.
- Ribeiro, H. and H. C. Ramos. 1999. Identification keys of the mosquitoes (Diptera: Culicidae) of continental Portugal, Acores and Madeira. European Mosq. Bull. 3: 1-11.
- Samanidou-Voyadjoglou, A. and R. Darsie. 1993. An annotated checklist and bibliography of the mosquitoes of Greece (Diptera: Culicidae). Mosq. Syst. 25: 177-185.
- Stojanovich, C.J. and H.G. Scott. 1993. Mosquitoes of the Republics of the Former Yugoslavia. Chester R. Stojanovich, 479 Riverside Rd., Watsonville, California. 81pp.*
- Ward, R.A. 1984. Second supplement to "A catalog of the mosquitoes of the world (Diptera: Culicidae)." Mosq. Syst. 16: 227-270.
- Ward, R.A. 1992. Third Supplement to "A catalog of the mosquitoes of the world (Diptera: Culicidae)." Mosq. Syst. 24: 177-230.

Other Diptera

- Povolny, D. and J. Verves. 1990. A preliminary list of Bulgarian Sarcophaginae (Diptera). Acta Entomol. Mus. Natl., Prague 43: 283-329.*
- Rognes, K. 1987. The taxonomy of the *Pollenia rudis* species group in the Holarctic region (Diptera: Calliphoridae). Syst. Entomol. 12: 475-502.*

Mammalia

Nowak, R.M. [ed.] 1991. Walker's Mammals of the World. 5th ed., John Hopkins University Press, Baltimore & London, 1629 pp.

Wilson, D.E. and D.M. Reeder. 1993. Mammal Species of the World: a Taxonomic and Geographic Reference. 2nd ed., Smithsonian Institution Press, Washington, DC, 1,206 pp.

Psychodidae

Leger, N., B. Pesson, B. and G. Madulo-Leblond. 1986a. [Phlebotomines in Greece (first part).] Bull. Soc. Pathol. Exot. 79: 386-397.*

Leger, N., B. Pesson, B. and G. Madulo-Leblond. 1986b. [Phlebotomines in Greece (second part).] Bull. Soc. Pathol. Exot. 79: 514-524*

Lewis, D.J. 1982. A taxonomic review of the genus *Phlebotomus* (Diptera: Psychodidae). Bull. Brit. Mus. Nat. Hist., Entomology Ser., 45: 1- 209.*

Seyedi-Rashti, M.A., A. Nadim, M.A. Rashti and M.A. Sayedi. 1992. The genus *Phlebotomus* (Diptera: Psychodidae : Phlebotominae) of the countries of the Eastern Mediterranean Region. Iranian J. Pub. Hlth. 21: 11-50.*

Reptiles

Defense Intelligence Agency. 1986. The Poisonous Snakes of Europe. Washington, D.C. 17 pp.

Harding, K.A. and K.R.G. Welch. 1980. Venomous Snakes of the World: a Checklist. Pergamon Press, Oxford. 188 pp.

Poisonous Snakes of the World, a Manual for Use by U.S. Amphibious Forces. 1966. NAVMED P-5099, BUMED, Department of the Navy, U.S. Gov. Print. Off., 212 pp.*

Scorpions

El Hennawy, H.K. and H.K. El Hennawy. 1990. Key to scorpion families (Arachnida: Scorpionida). Serket 2: 14-19.*

Sissom, W.D. 1990. Systematics, Biogeography, and Paleontology. pp. 64-136. In: The Biology of Scorpions, G.A. Polis [ed.] Stanford University Press.*

Vachon, M. 1952. [Studies on scorpions.] Insitut Pasteur d'Algérie. Algiers, Algeria. 481 pp.

Siphonaptera

Adams, N.E. and R.E. Lewis. 1985. An annotated catalogue of primary types of Siphonaptera in the National Museum of Natural History, Smithsonian Institution. Smithsonian Contributions to Zoology. No. 56: 1-86.

Lewis, R.E. 1967. The fleas (Siphonaptera) of Egypt. An illustrated and annotated key. J. Parasitol. 53: 863-885.*

Lewis, R.E. 1990. The Ceratophyllidae: currently accepted valid taxa (Insecta: Siphonaptera). Theses Zoologicae, volume 13. R. Fricke [ed.] Koeltz Scientific Books. Koenigstein, Germany. 267 pp.

Lewis, R.E. and J.H. Lewis. 1989. Catalogue of invalid genus-group and species-group names in the Siphonaptera (Insecta). These Zoologicae, Volume 11. R. Fricke [ed.]. Koeltz Scientific Books. Koenigstein, Germany. 263 pp.

Skuratowicz, W., K. Bartkowska and G. Bachvarov. 1982. Fleas (Siphonaptera) of small mammals and birds collected in Bulgaria. Frag. Faun. 27: 101-140.

Traub, R., M. Rothschild and J.F. Haddow. 1983. The Rothschild Collection of Fleas. The Ceratophyllidae: Key to the Genera and Host Relationships. With Notes on Their Evolution, Zoogeography and Medical Importance. Privately published by M. Rothschild and R. Traub. Distributed by Academic Press. 288 pp.

Tabanidae

Trojan, P. 1959. Keys to Polish Diptera (Tabanidae). Polski Awiazek Ent. Key Ser. No. 27: 1-69.*

Trojan, P. 1979. Tabanidae (Insecta: Diptera) Fauna Pol., Warsaw 8:1-309.*

Ticks (Ixodidae, Argasidae)

Balashov, Y. 1972. Bloodsucking ticks. *Bull. Entomol. Soc. Amer.* 8: 1- 376.

Dusbabek, F. and B. Rosicky. 1976. Argasid ticks (Argasidae, Ixodoidea) of Czechoslovakia. *Pirodoved. Pr. Ustavu Cesk. Akad. Brne* 10: 1-43.*

Sonenshine, D.E., C.M. Clifford, and G.M. Kohls. 1966. The systematics of the subfamily Ornithodorinae (Acarina: Argasidae). III. Identification of the larvae of the Eastern Hemisphere. *Ann. Entomol. Soc. Amer.* 59: 92-122.*

*Papers marked with an asterisk include a taxonomic key for identification of species. References without keys for identification usually contain a checklist of species known from a given geographic area or a list of species collected during extensive surveys of an area.

Appendix F: Personal Protective Measures

Personal protective measures are the first line of defense against arthropod-borne disease and, in some cases, may be the only protection for deployed military personnel. Proper wearing of the uniform and appropriate use of repellents can provide high levels of protection against blood-sucking arthropods. The uniform fabric provides a significant mechanical barrier to mosquitoes and other blood-sucking insects. Therefore, the uniform should be worn to cover as much skin as possible if weather and physical activity permit. When personnel are operating in tick-infested areas, they should tuck their pant legs into their boots to prevent access to the skin by ticks, chiggers, and other crawling arthropods. They should also check themselves frequently for ticks and immediately remove any that are found. If a tick has attached, seek assistance from medical authorities for proper removal or follow these guidelines from TIM 36, Appendix IX A.

1. **Grasp the tick's mouthparts** where they enter the skin, using pointed tweezers.
2. **Pull out** slowly and steadily with gentle force.
 - a. Pull in the reverse of the direction in which the mouthparts are inserted, as you would for a splinter.
 - b. **Be patient** – The long, central mouthpart (called the hypostome) is inserted in the skin. It is covered with sharp barbs, sometimes making removal difficult and time consuming.
 - c. Many hard ticks secrete a cement-like substance during feeding. This material helps secure their mouthparts firmly in the flesh and adds to the difficulty of removal.
 - d. It is important to continue to pull steadily until the tick can be eased out of the skin.
 - e. **Do not** pull back sharply, as this may tear the mouthparts from the body of the tick, leaving them embedded in the skin. If this happens, don't panic. Embedded mouthparts are comparable to having a splinter in your skin. However, to prevent secondary infection, it is best to remove them. Seek medical assistance if necessary.
 - f. **Do not** squeeze or crush the body of the tick because this may force infective body fluids through the mouthparts and into the wound.

- g. **Do not** apply substances like petroleum jelly, fingernail polish remover, repellent pesticides, or a lighted match to the tick while it is attached. These materials are either ineffective or, worse, may agitate the tick and cause it to salivate or regurgitate infective fluid into the wound site.
 - h. If tweezers are not available, grasp the tick's mouthparts between your fingernails, and remove the tick carefully by hand. Be sure to wash your hands -- especially under your fingernails -- to prevent possible contamination by infective material from the tick.
3. Following removal of the tick, **wash the wound** (and your hands) with soap and water and **apply an antiseptic**.
 4. **Save the tick** in a jar, vial, small plastic bag, or other container for identification should you later develop disease symptoms. Preserve the tick by either adding some alcohol to the jar or by keeping it in a freezer. Storing a tick in water will not preserve it. Identification of the tick will help the physician's diagnosis and treatment, since many tick-borne diseases are transmitted only by certain species.
 5. **Discard** the tick after one month; all known tick-borne diseases will generally display symptoms within this time period.

Folklore remedies such as petroleum jelly or hot matches do little to encourage a tick to detach from skin. In fact, they may make matters worse by irritating the tick and stimulating it to release additional saliva, increasing the chances of transmitting pathogens. These methods of tick removal should be avoided. In addition, a number of tick removal devices have been marketed, but none are better than a plain set of fine-tipped tweezers.

Newly developed repellents provide military personnel with unprecedented levels of protection. An aerosol formulation of permethrin (NSN 6840-01-278-1336) can be applied to the uniform according to label directions, but not to the skin. This will impart both repellent and insecticidal properties to the uniform material that will be retained through numerous washings. An extended formulation lotion of N, N-diethyl-m-toluamide (deet) (NSN 6840-01-284-3982) has been developed to replace the 2 oz. bottles of 75% deet in alcohol. This lotion contains 33% active ingredient. It is less irritating to the skin, has less odor and is generally more acceptable to the user. A properly worn Battle Dress Uniform (BDU) impregnated with permethrin, combined with use of extended duration deet on exposed skin, has been demonstrated to provide nearly 100% protection against a variety of blood-sucking arthropods. This dual strategy is termed the DoD ARTHROPOD REPELLENT SYSTEM. In addition, permethrin may be applied to bednets, tents, and other field items as appropriate. Complete details

regarding these and other personal protective measures are provided in TIM 36, Personal Protective Techniques Against Insects and Other Arthropods of Military Significance (1996).

Appendix G

Bioscience and State Department Contacts in Central Europe

1. Regional Contacts.

World Health Organization (WHO)
Regional Office for Europe (EURO)
8, Scherfigsvej
DK-2100 Copenhagen 0
Denmark

Phone: (0045) 39-17-17-17
FAX: (0045) 398-17-18-18
e-mail: < postmaster@who.dk >
website: < http://www.who.dk >

Centers for Disease Control and Prevention
Division of Quarantine
National Center for Infectious Diseases
1600 Clifton Road, NE
Atlanta, GA 30333
U.S.A.

Phone: (404) 639-3311
e-mail: < netinfo@cdc.gov >
Website:
<http://www.cdc.gov/travel/index.htm >

Commander
USACHPPM-EUR
ATTN: MCHB-AE-EN, CMR 402
APO, AE 09180

Phone: (011) 49-6371-86-8540 (Germany)
DSN: 486-8540
FAX: (011) 49-6371-86-7198 / -8958

2. **Albania.**

Ambassador
Rruga E. Labinoti 103
Tirana, Albania
PSC 59, Box 100 (A)
APO, AE 09624

Phone: [355] (42) 328-75, 335-20
FAX: [355] (42) 322-22

WHO Liaison Office
ATTN: WHO Liaison Officer
c/o Ministry of Health
Tirana, Albania

Phone: [355] (42) 64-270
FAX: [355] (42) 64-270
e-mail: < miho@who.tirana.al >

3. **Bosnia and Herzegovina.**

Ambassador
443 Ul. Dure Dakovica
Sarajevo
Bosnia and Herzegovina

Phone: [387] (71) 445-700, 667-391,
667-389, 667-743, 667-390, 659-969,
659-992
FAX: [387] (71) 659-722

WHO Liaison Office
ATTN: WHO Liaison Officer
Marsala Tita Str. 9/2
71 000 Sarajevo
Bosnia and Herzegovina

Phone: [387] (71) 20-18-15
FAX: [387] (71) 20-18-15
e-mail: < whoho@bih.net.ba >

4. **Bulgaria.**

Ambassador
1 Saborna Street
Sophia, Bulgaria
Unit 1335
APO, AE 09213-1335

Phone: [359] (2) 980-52- 41 (through - 48)
FAX: [359] (2) 981-89-77

WHO Liaison Office
ATTN: WHO Liaison Officer
c/o Ministry of Health
5, Sveta Nedelja Square
Sofia 1000, Bulgaria

Phone: [359] (2) 981-02-25
FAX: [359] (2) 987-27-92
e-mail: < wholobg@who.bg >

5. **Croatia.**

Ambassador
Andrije Hebranga 2
Zagreb, Croatia

Phone: [385] (1) 455-55-00
FAX: [385] (1) 455-85-85

WHO Liaison Office
ATTN: WHO Liaison Officer
c/o Institute for Health Organization
and Economics
WHO Collaborating Centre for
Health Development

Phone: [385] (1) 61-76-502
FAX: [385] (1) 61-76-504
e-mail: < b.skupnjak@who.hr >

Savska 41
41000 Zagreb, Croatia

6. Czech Republic.

Ambassador
Trziste 15, 11801
Prague 1, Czech Republic
Unit 28129
APO, AE 09114

Phone: [420] (2) 5732-0663, 5731-3814
FAX: [420] (2) 5732-0584

or State Pouch: American Embassy Prague, Washington, DC 20521-5630

WHO Liaison Office
ATTN: WHO Liaison Officer
c/o Ministry of Health
Palackého nám 4
128 01 Prague 2
Czech Republic

Phone: [420] (2) 2497-2486
FAX: [420] (2) 291-517
e-mail: < wholocz@who.cz >

7. Greece.

Ambassador
91 Vasilissis Sophias Boulevard
10160 Athens, Greece
PSC 108
APO, AE 09842-0108

Phone: [30] (1) 721-2951
FAX: [30] (1) 645-6282

Consulate general, Thessaloniki

8. Hungary.

Ambassador
V. Szabadsag Ter 12
1054 Budapest, Hungary

Phone: [36] (1) 267-4400, after hours -
269-9331,
FAX: [36] (1) 269-9326 after hours - 269-
9339

mail: Pouch: American Embassy Budapest, Washington, DC 20521-5270

WHO Liaison Office
ATTN: WHO Liaison Officer
c/o Ministry of Welfare

Phone: [36] (1) 331-7450
FAX: [36] (1) 269-1303
e-mail: < wholohu@who.hu >

Arany Jaanos u. 6-8
H-1361 Budapest V, Hungary

9. Macedonia.

Ambassador
Bul. Ilindenska bb
9100 Skopje, Macedonia

Phone: [389] (91) 116-180
FAX: [389] (91) 117-103

mail: American Embassy Skopje, Dept.of State, Washington, DC 20521-7120
(pouch)

WHO Liaison Office
ATTN: WHO Liaison Officer
c/o Ministry of Health
Vodnjanska bb
91000 Skopje, Macedonia

Phone: [389] (91) 121-142
FAX: [389] (91) 121-142
e-mail: < kisman@unet.com.mk >

10. Poland.

Ambassador
Aleje Ujazdowskie 29/30 00-054
Warsaw, Poland

Phone: [48] (22) 628-30-41
FAX: [48] (22) 628-82-98

mail: American Embassy Warsaw, U.S. Dept. of State, Washington, DC 20521-5010 (pouch)
Consulate general, Krakow

WHO Liaison Office
ATTN: WHO Liaison Officer
c/o Ministry of Health and Social Welfare
Dluga 38/40
00-238 Warsaw, Poland

Phone: [48] (22) 635-94-96
FAX: [48] (22) 831-08-92
e-mail: < whoo@pol.pl >

11. Romania.

Ambassador
Strada Tudor Arghezi 7-9
Bucharest, Romania

Phone: [40] (1) 210-01-49, 210-40-42
FAX: [40] (1) 210-03-95

mail: American Embassy Bucharest, Dept. of State, Washington, DC 20521-5260 (pouch)

branch office, Cluj-Napoca

WHO Liaison Office
ATTN: WHO Liaison Officer
Str. Pitar Mos Nos. 7-13
70151 Bucharest, Romania

Phone: [40] (1) 211-0911
FAX: [40] (1) 210-0173
e-mail: < wholoro@who.eunet.ro >

12. Serbia and Montenegro.

[**NOTE:** the U.S. and Serbia and Montenegro do not maintain full diplomatic relations.]

Chief of Mission
Kneza Milosa 50
11000 Belgrade
Serbia and Montenegro

Phone: [381] (11) 645655
FAX: [381] (11) 645332

mail: American Embassy, Belgrade, Dept. of State, Washington, DC 20521-5070 (pouch), Unit 1310, APO, AE 09213-1310

13. Slovakia.

Ambassador
Hviezdoslavovo Namestie 4
81102 Bratislava, Slovakia

Phone: [42] (7) 533-0861, 533-3338
FAX: [42] (7) 533-5439

WHO Liaison Office
ATTN: WHO Liaison Officer
Limbova 3
83007 Bratislava, Slovakia

Phone: [421] (7) 373-662
FAX: [421] (7) 373-662
e-mail: < wholosk@mbox.bts.sk >

14. Slovenia.

Ambassador
P.O. Box 254
Prazakova 4,
1000 Ljubljana, Slovenia

Phone: [386] (61) 301-427, 301-472,
301-485
FAX: [386] (61) 301-401

mail: American Embassy Ljubljana, Dept. of State, Washington, DC 20521-7140 (pouch)

Appendix H: Glossary

- acaricide - a substance developed to kill ticks and mites.
- adulticide - insecticides used to kill the adult stages of an insect.
- anaphylaxis - an unusual and severe allergic reaction of an organism to a foreign protein or other substances.
- anthropophilic - the preference of insects and other arthropods to suck blood from humans rather than from animals.
- autochthonous - transmission of a disease in the place where the disease occurred.
- autogenous - not requiring a bloodmeal to produce eggs.
- biomics - the ecology of an organism.
- biotope - a habitat characterized by environmental conditions and its community of animals and plants.
- campestral - relating to fields or open country.
- carrier - a person or animal that harbors infectious organisms but is free of clinical disease. Generally synonymous with reservoir.
- case fatality rate - the percentage of persons diagnosed as having a specific disease who die as a result of that illness within a given period.
- cephalothorax - a body region consisting of head and thoracic segments.
- cercariae - free-living stage in the life cycle of Schistosomes that emerges from snails and infects vertebrate hosts.
- chelicerae - a pair of appendages used as mouthparts in arachnids such as scorpions, spiders, and ticks.
- chemoprophylaxis - the administration of a chemical to prevent the development of an infection or the progression of an infection to active disease.
- commensal - living in close association with another organism.
- crepuscular - the twilight periods of dusk and dawn.
- diapause - a period of arrested development and reduced metabolic rate, during which growth and metamorphosis cease.
- diurnal - activities occurring during the daytime.
- ectoparasite - a parasite that lives on the exterior of its host.
- endemic - the constant presence of a disease or infection within a given geographic area.
- endophagic - an arthropod that prefers to feed indoors.
- endophilic - the tendency of arthropods to enter human structures.
- enzootic - a disease that primarily infects animals and is present in an animal community at all times.
- epidemic - the occurrence of cases of an illness (or an outbreak) that is clearly in excess of normal expectancy.
- epizootic - an outbreak of a disease within an animal population.
- eutrophic - rich in nutrients; usually applied to aquatic ecosystems.
- exophagic - the tendency of an arthropod to feed outdoors.

exophilic - the tendency of blood-sucking arthropods to feed and rest outdoors.
facultative - not obligatory; characterized by the ability to adjust to circumstances.
family - a group of related genera.
focus (pl. foci) - a specific localized area.
genus (pl. genera) - a group of closely related species.
gonotrophic cycle - the time between feeding and oviposition.
inapparent infection - the presence of infection in a host without clinical symptoms.
incidence - the number of new cases of a specific disease occurring during a certain period of time.
incubation period - the time interval between initial contact with an infectious agent and the first appearance of symptoms associated with the infection.
indigenous - living or occurring naturally in a particular environment or area.
infection rate - the proportion (expressed as a percent) of a vector or host population that is infected.
infective - an organism that can transmit an infectious agent to another individual.
instar - an insect between successive molts.
larva (pl. larvae) - the immature stage, between the egg and pupa of an insect, or the six-legged immature stage of a tick.
larvicide - insecticides used to kill larvae or immature stages of an insect.
larviparous - insects that deposit larvae rather than eggs on a host, food source, or other substrate.
maggot - legless larva of flies (Diptera).
mechanical transmission - the vector transmits the pathogen on contaminated mouthparts, legs, or other body parts, or by passage through the digestive tract without change.
miracidium (pl. miracidia) - ciliated, first larval stage in the life cycle of Schistosomes that penetrates and infects a snail, undergoing further development in the snail.
molluscicide - a chemical substance used for the destruction of snails and other molluscs.
myiasis - the invasion of human tissues by fly larvae.
night soil - human excrement used as fertilizer.
nosocomial - originating in a hospital or medical treatment facility.
nulliparous - a female arthropod that has not laid eggs.
nymph - an immature stage of an insect that does not have a pupal stage or an eight-legged immature tick or mite.
obligate - necessary or compulsory; characterized by the ability to survive only in a particular environment.
pandemic - a widespread epidemic disease distributed throughout a region or continent.
parous - a female arthropod that has laid eggs.
pedipalps - the second pair of appendages of an arachnid.
periurban - relating to an area immediately surrounding a city or town.
prevalence - the total number of cases of a disease in existence at a certain time in a designated area.

pupa (pl. pupae) - a nonfeeding and usually inactive stage between the larval and adult stage.

quest (questing) - the behavior of ticks waiting in search of a passing host.

refractory - a host or vector that will not permit development or transmission of a pathogen.

reservoir - any animal, plant or substance in which an infectious agent survives and multiplies.

rodenticide - a chemical substance used to kill rodents, generally through ingestion.

ruminants - relating to a group of even-toed mammals, such as sheep, goats and camels, that chew the cud and have a complex stomach.

sequelae - any aftereffects of disease.

species complex - a group of closely related species, the taxonomic relationships of which are sometimes unclear, making individual species identification difficult.

steppe - a vast, arid and treeless tract found in southeastern Europe or Asia.

sylvatic - related to a woodland or jungle habitat.

synanthropic - animals that live in close association with man.

synergist - a chemical that may have little or no toxicity in itself but, when combined with a pesticide, greatly increases the pesticide's effectiveness.

transovarial transmission - passage of a pathogen through the ovary to the next generation .

transstadial transmission - passage of a pathogen from one stage of development to another after molting.

ultra low volume (ULV) - the mechanical dispersal of concentrated insecticides in aerosols of extremely small droplets that drift with air currents.

urticaria - a reaction of the skin marked by the appearance of smooth, slightly elevated patches (wheals) that are redder or paler than the surrounding skin and often associated with severe itching.

vector - an organism that transmits a pathogen from one host to another.

vector competence - the relative capability of a vector to permit the development, multiplication and transmission of a pathogen.

vesicant - a blistering agent.

viremia - a virus that is present in the blood.

virulence - the degree of pathogenicity of an infectious agent.

xerophilic - tolerant of dry environments.

zoonosis - an infectious disease of animals transmissible under natural conditions from nonhumans to humans.

zoophilic - the preference of insects and other arthropods to feed on animals other than humans.

Appendix I

Internet Websites on Medical Entomology and Vector-borne Diseases

A. Primary Sites

1. The Armed Forces Pest Management Board's website provides information about the Board as well as Army, Navy and Air Force entomology programs. Users can download Board publications, including Technical Information Memorandums, Disease Vector Ecology Profiles, and Technical Information Bulletins and search the Defense Pest Management Information Analysis Center's literature database.
<<http://www.afpmb.org/>>
2. ProMED (Program for Monitoring Emerging Diseases), with current information on disease outbreaks.
<<http://www.fas.org/promed>>
3. Iowa State University's comprehensive site on medical entomology, with excellent information and links to over 20 additional sites.
<<http://www.ent.iastate.edu/>>
4. WHO disease outbreak information – emerging and communicable disease information from the WHO and its databases. The tropical medicine databases are the most useful for vector-borne diseases. Access can also be obtained to the Weekly Epidemiological Record.
<<http://www.who.int/emc/index.html>>
5. The Walter Reed Biosystematic Unit's online information regarding taxonomic keys, diseases transmitted by mosquitoes, and mosquito identification modules.
<<http://wrbu.si.edu/>>
6. Centers for Disease Control and Prevention – information on the CDC's travel alerts, including access to country health profiles, vaccine recommendations, State Department entry requirements, and publications.
<<http://www.cdc.gov/travel/>>
7. The National Library of Medicine's biomedical databases, especially Medline. Provides complete references and abstracts to more than 9 million journal articles from biomedical publications.
<<http://www.nlm.nih.gov/>>

8. The Malaria Foundation International's site for general resources on malaria available through the worldwide web. Includes references, malaria advisories, and lists of other malaria websites.
<<http://www.malaria.org>>
9. The WHO site for information on vector-borne diseases, including disease distribution, information on disease outbreaks, travel alerts, WHO research programs, and progress on control.
<<http://www.who.ch/>>
10. The CDC's site on encephalitis information, as published in the Morbidity and Mortality Weekly Report. Includes case definition and disease outbreak information.
<http://www.cdc.gov/epo/mmwr/other/case_def/enceph.html>
11. Information from the University of Florida's website on mosquitoes and other biting flies.
<<http://hammock.ifas.ufl.edu/text/ig/8804.html>>
12. Information on ticks and other ectoparasites from the University of Rhode Island's Tick Research Laboratory.
<<http://www.uri.edu/artsci/zool/ticklab/>>
13. Information on plague available from the CDC's Morbidity and Mortality Weekly Report.
<http://www.cdc.gov/epo/mmwr/other/case_def/plague.html>
14. A list of websites and servers pertaining to entomology from Colorado State University. Over 30 websites are listed.
<<http://www.colostate.edu/Depts/Entomology/ent.html>>
15. AGRICOLA is a comprehensive source of bibliographic citations covering all aspects of agriculture and many areas of the life sciences, including medical entomology and pest management.
< <http://www.nalusda.gov/>>
16. Medical Matrix provides access to hundreds of sites for medical information, with emphasis on clinical medicine. It includes 75 sites on infectious diseases.
<<http://www.medmatrix.org>>

B. Additional Sites

1. Lyme Disease Network – information on Lyme disease, including research abstracts, treatments for Lyme disease, newsletter, conferences, and professional resources.
<<http://www.lymenet.org>>
2. The USDA plant database – includes the integrated taxonomic information system.
<<http://plants.usda.gov/>>
3. University of Sydney, Medical Entomology – contains mosquito keys, fact sheets, and photos of mosquitoes.
<<http://medent.usyd.edu.au>>
4. American Society of Tropical Medicine and Hygiene – information on the ASTMH’s programs, conferences, newsletters, publications, and resources.
<<http://www.astmh.org>>
5. The American Mosquito Control Association’s site containing information on mosquito biology, AMCA programs, conferences, newsletters, publications, and resources.
<<http://www.mosquito.org>>
6. Reuters’ search engine on health news pertaining to health issues around the world.
<<http://www.reutershealth.com/>>
7. The ORSTOM (now IRD) home page includes information about the organization’s medical research program in Asia, Africa, and Latin America. Bulletins and publications on its research are offered.
<<http://www.orstom.fr/>>
8. Emory University’s website allows access to the University’s extensive database of medical and scientific literature.
<<http://www.medweb.emory.edu/medweb/>>
9. The Entomological Society of America offers information on its overall services, including conferences, journals, references, membership, and literature available for ordering.
<<http://www.entsoc.org>>
10. Travel Health Online contains country profiles with health precautions and disease risk summaries, general travel health advice, contacts for providers of pretravel health services, and access to US State Department publications.

<<http://www.tripprep.com>>

APPENDIX J METRIC CONVERSION TABLE

Metric System		U.S. Customary System	
LINEAR MEASURE		LINEAR MEASURE	
10 millimeters	= 1 centimeter	12 inches	= 1 foot
10 centimeters	= 1 decimeter	3 feet	= 1 yard
10 decimeters	= 1 meter	5 ½ yards	= 1 rod
10 meters	= 1 decameter	40 rods	= 1 furlong
10 decameters	= 1 hectometer	8 furlongs	= 1 mile
10 hectometers	= 1 kilometer	3 land miles	= 1 league
AREA MEASURE		AREA MEASURE	
100 sq. millimeters	= 1 sq. centimeter	144 sq. inches	= 1 sq. foot
10,000 sq. centimeters	= 1 sq. meter	9 sq. feet	= 1 sq. yard
1,000,000 sq. millimeters	= 1 sq. meter	30 ¼ sq. yards	= 1 sq. rod
100 sq. meters	= 1 sq. are	160 sq. rods	= 1 acre
100 ares	= 1 hectare	640 acres	= 1 sq. mile
100 hectares	= 1 sq. kilometer	1 sq. mile	= 1 section
1,000,000 sq. meters	= 1 sq. kilometer	36 sections	= 1 township
VOLUME MEASURE		LIQUID MEASURE	
1 liter	= 0.001 cubic meters	4 gills (2 cups)	= 1 pint
10 milliliters	= 1 centiliter	2 pints	= 1 quart
10 centiliters	= 1 deciliter	4 quarts	= 1 gallon
10 decaliters	= 1 liter	DRY MEASURE	
10 liters	= 1 decaliter	2 pints	= 1 quart
10 decaliters	= 1 hectoliter	8 quarts	= 1 peck
10 hectoliters	= 1 kiloliter	4 pecks	= 1 bushel
WEIGHT		WEIGHT	
10 milligrams	= 1 centigram	27 11/32 grains	= 1 dram
10 centigrams	= 1 decigram	16 drams	= 1 ounce
10 decigrams	= 1 gram	16 ounces	= 1 pound
10 grams	= 1 decagram	100 pounds	= 1 hundredweight
10 decagrams	= 1 hectogram	20 hundredweight	= 1 ton
10 hectograms	= 1 kilogram		
1,000 kilograms	= 1 metric ton		

Kitchen Measurements

3 tsp.	= 1 tbsp.	5 1/3 tbsp.	= 1/3 cup	2 cups	= 1 pint	2 pints	= 1 quart
4 tsp.	= ¼ cup	16 tbsp.	= 1 cup	4 cups	= 1 quart	4 quarts	= 1 gallon

Temperature

$$\text{Celsius} = \frac{5}{9}(\text{F}-32) \qquad \text{Fahrenheit} = \frac{9\text{C} + 32}{5}$$

Conversion Table

To Convert	Into	Multiply by	To Convert	Into	Multiply by	To Convert	Into	Multiply by	
Centimeters	Inches	.394	Liters	Cups	4.226	Miles	Feet	5,280	
	Feet	.0328		Pints	2.113		Yards	1,760	
	Meters	.01		Gallons	.264		Kilometers	1.609	
	Millimeters	10		Milliliters	1000		Pints	Liters	.473
Meters	Centimeters	100	Grams	Quarts	1.057	Quarts	Liters	.5	
	Feet	3.281		Ounces	.035		Gallons	.125	
	Inches	39.37		Pounds	.002		Pints	2	
	Kilometers	.001		Kilograms	.001		Liters	.946	
	Miles	.0006214		Grams	1,000		Gallons	.25	
	Millimeters	1000		Ounces	35.274		Pints	8	
	Yards	1.093		Pounds	2.205		Gallons	Liters	3.785
Kilometers	Feet	3281	Inches	Centimeters	2.54	Ounces	Quart	4	
	Meters	1000		Feet	.0833		Grams	28.35	
	Miles	.621		Meters	.0264		Pounds	.0625	
	Yards	1093		Yards	.0278		Kilograms	.028	
				Inches	36		Pounds	Grams	453.59
				Feet	3		Ounces	16	
				Meters	.914		Kilograms	.454	
		Miles	.0005682						