Armed Forces Pest Management Board

Disease Vector Ecology Profile

China

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Preface and Acknowledgements

Disease Vector Ecology Profiles (DVEPs) are concise summaries of vector-borne and other militarily significant diseases that occur in specific countries. DVEPs focus on vector-borne diseases and emphasize essential epidemiology, vector bionomics and behavior, and pesticide resistance. A selected bibliography of pertinent diseases and disease vector literature is included. DVEPs are not meant to serve as scientific documents but rather as synopses of relevant entomological and arthropod-borne disease information. DVEPs are compiled from unclassified scientific literature. They are intended to provide a historical profile of arthropod-borne disease epidemiology in the recent past for selected geographical areas. The epidemiology of arthropod-borne disease is dynamic, and incidence and prevalence are constantly changing. This is especially true of nations undergoing rapid development and ecological change, and those areas experiencing migrations of large refugee populations as a result of civil strife. This document should be supplemented with recent information on foreign public health status and medical developments. Component medical department activities may have updated regional information for their areas of responsibility. Current disease risk assessment and additional information on parasitic and communicable disease, and other aspects of medical intelligence can be obtained from the National Center for Medical Intelligence, Fort Detrick, Frederick, MD 21701, 301-619-7574, DSN 312-343-7574, ncmi_ops@dodiis.mil, https://www.ncmi.dodiis.mil/. Updated species lists are obtained from the Walter Reed Biosystematics Unit at the Smithsonian Institution. Individuals possessing additions, corrections, or suggestions are encouraged to communicate this information to the Chief, Strategy and Information Division at the Armed Forces Pest Management Board. In addition to DVEPs, the AFPMB can provide information on pest management and medical entomology.

Acknowledgements

CPT Joseph W. Margotta, MS, USA, Ph.D., Visiting Scientist, United States Army Water, Air, Monitoring, and Analysis Group, Environmental Functional Area, Lawrence Livermore National Laboratory, Livermore, CA, produced this first-ever China DVEP. The Armed Forces Pest Management Board, on behalf of CPT Margotta's Army, Navy, Air Force, and Marine Corps colleagues, commends him for his generous collaboration and technical excellence.

Overview of China

China is only 2.5% smaller in total area compared to the United States but has approximately one billion more citizens. China shares borders with 15 different countries. These borders range from 72 kilometers (km) with Afghanistan to more than 3,600 km with Russia. China's coastline includes four bodies of water: The Sea of Japan, Korea Bay, East China Sea, and South China Sea. The country has a diverse landscape including the Gobi and Taklamakan Deserts in the arid north and subtropical forests in the south. China is separated from much of south and central Asia by the Himalaya, Karakoram, Pamir, and Tian Shan mountain ranges. Three main rivers, the Huang He (Yellow River), Yangtze, and Xijiang (West River), originate in China's remote western territory and flow through the more populated eastern regions. China comprises three major geographic regions: (1) In the southwest, the Plateau of Tibet, which is located in both Xizang (Tibet) and Tsinghai, has an average elevation of 4,000 m above sea level. The highest point in China is Mount Everest at 8,850 m in southern Tibet. Most of China's remaining forests are found in the southwest. The westernmost area (Chiang-t'ang) has an average elevation of about 5,000 m. This region includes Turpan Pendi, the lowest point in China (-154 m), which is isolated in a deep valley between mountain ranges in the far northcentral part of Xinjiang Province. The deserts and mountains that fill the western half of China are so forbidding that less than 10% of the population lives there. (2) A highland area with elevations between 900 and 1,800 m includes the Mongolian and Loess plateaus in the Tarim and Upper Szechwan Basins and the Yunnan-Kweichow highlands. (3) The easternmost region, extending from the Yunnan-Kweichow highlands to the Yellow Sea, lies less than 450 m above sea level. It contains the country's largest lowland areas, the Manchurian and North China Plains and the Lower Szechwan Basin.

China's diverse climate, which varies from tropical in the south to subarctic in the north, is influenced by Pacific and Siberian air masses. Except at extreme high elevations, hot and humid summer weather is typical throughout China, when moist tropical Pacific air masses bring monsoon rains to the south and east. The hillier and more mountainous areas found in southern China have wetter, warmer temperatures that produce thick forests on uncultivated land. Northern summers also are very rainy. Winters are dominated by bitterly cold, dry Siberian air masses that often penetrate to the southern provinces. Little precipitation falls during the colder months, when clear days with low humidity and temperatures are common. During late winter and spring, strong north winds sweep across northern China. These winds stir up dust storms, causing haze. The most extreme temperatures occur in the Gobi and Taklimakan Deserts, where summer daytime temperatures regularly exceed 38°C and winter daily lows fall to -34°C. Tibet and Manchuria also have long, cold winters. The southeastern mountains have the highest rainfall, often more than 1,500 mm annually. The central highland areas receive about 1,000 mm of rainfall in the east and 300 mm in the west. Annual rainfall in the Tibetan Highlands is about 200 mm, and only 10 mm or less in the western and northern deserts. Typhoons along the lower coastal areas occur mostly in August but have occurred as late as December. The eastern coastal areas are vulnerable to floods, earthquakes, tsunamis, and other marine calamities.

Figure 1: Map of China (Source: cia.gov)

Unclassified

Disease Risk Summary

Food- and Water-borne Diseases

Gastroenteric diseases: Transmission of bacteria, protozoa, and viruses that cause diarrheal diseases occurs throughout China. Service members should not consume food or water from unapproved sources.

Vector-borne Diseases

Chikungunya: Chikungunya virus is transmitted primarily by *Ae. aegypti*, with some possible involvement of *Ae. albopictus* mosquitoes. Transmission and outbreaks are intermittent and unpredictable. Risk is year-round in the southern provinces, while further north the transmission season progressively shortens to approximately April through October. Although transmission is intermittent and unpredictable, risk distribution likely parallels that of dengue.

Crimean-Congo Hemorrhagic Fever: The Crimean-Congo Hemorrhagic Fever (CCHF) virus is transmitted by several species of hard ticks, especially those of the genera *Hyalomma, Boophilus*, and *Rhipicephalus*. Risk is year-round in the southern provinces, and present primarily in rural areas due to its association with livestock. The transmission season for ticks shortens progressively at higher latitudes, lasting from approximately April through October in central China, and approximately April through September in the northern provinces, including Xinjiang. Risk is likely greater in northern China, particularly in Xinjiang Autonomous Region. In addition to being vectored by ticks, CCHF may also be transmitted by coming into contact with the blood of an infected person or animal.

Dengue: Dengue fever (DF) is transmitted by *Aedes* mosquitoes. They are day-biting mosquitoes that often breed in artificial containers, such as flowerpots or discarded tires found in peridomestic settings. The disease risk is year-round in the southern provinces, while the transmission season is progressively shorter (from April through October) in the north. Risk is low in modern, major cities including Hong Kong and Shanghai. Infection with any of the four-dengue serotypes (dengue virus 1, 2, 3, and 4) can produce the full spectrum of illness and severity.

Encephalitis, Japanese: The Japanese encephalitis (JE) virus is transmitted by *Culex* mosquitoes, which are night-biting mosquitoes that breed in flooded rice fields or similar environments. Risk of transmission to humans is highest in areas where pigs and flooded rice paddies are in close proximity. The risk is year-round in the southern provinces of Yunnan, Guizhou, Guangxi (Autonomous Region), Hainan, and the southern parts of Guangdong. The transmission season shortens progressively at higher latitudes, lasting from approximately April through October in central China, and approximately May through September in the northernmost risk area.

Encephalitis, Tick-borne: Tick-borne encephalitis (TBE) is a viral infection of the central nervous system transmitted by multiple species of hard ticks (particularly *Ixodes ricinus* or *Ix. persulcatus*), usually after travel to rural or forested areas. Risk is year-round and occurs primarily in rural areas and varies with latitude. Risk is year-round in the southern provinces. The transmission season shortens progressively at higher latitudes, lasting from approximately April through October in central China, and approximately April through September in the northern provinces, including Xinjiang. Natural foci are located in the forested areas of Nei Mongol in northern China, the Hunchun area (Jilin Province), and the subtropical region of western Yunnan Province near the Burmese border.

Leishmaniasis: The disease is transmitted by sand flies, which typically bite at night and breed in dark places rich in organic matter, particularly rodent or other animal burrows. Other suitable habitats include leaf litter, rubble, loose earth, caves, and rock holes. Abandoned dwellings, sometimes used by troops as temporary quarters, can also harbor significant numbers of sand flies. Stables and poultry pens in peridomestic areas also may harbor sand flies. When symptomatic, visceral leishmaniasis (VL) causes a severe febrile illness, which typically requires hospitalization with convalescence over 7 days. Cutaneous infection is unlikely to be debilitating, though lesions can be disfiguring. Definitive treatment previously required non-urgent evacuation to the continental United States; currently, not all cases require evacuation.

Lyme Disease: Lyme disease is transmitted primarily by the nymphal stage of *Ixodes* ticks (hard ticks), which are widely distributed in deciduous forests and grasslands or areas of scrubby vegetation. Risk is year-round, but the transmission season shortens progressively at higher latitudes, lasting from approximately April through October in central China, and approximately April through September in the northern provinces.

Malaria: *Plasmodium* parasites are transmitted by the *Anopheles* mosquitoes which typically bite at night and breed in a variety of locations - including slow moving streams, marshes, and lagoons - and are typically associated with rural environments. Risk is year-round in the southern provinces of Yunnan, Guizhou, Guangxi (Autonomous Region), Hainan, and the southern parts of Guangdong. Malaria is present at low levels across a wide expanse of rural China. The highest incidence occurs in Anhui, Hainan, and Yunnan Provinces. Risk is essentially zero in urban areas. Doxycycline resistant *P. falciparum, P. vivax, P. ovale,* or other species are unlikely. Chloroquine, mefloquine hydrochloride, and sulfadoxine-pyrimethamine resistance in *P. falciparum* has been reported in parts of Yunnan, Guangxi, Guangdong, and Hainan Provinces.

Plague: Multiple flea species transmit plague. The oriental rat flea (*Xenopsylla cheopis*) is the most efficient vector for transmission of plague to humans. Bubonic plague typically occurs as sporadic cases among people who encounter wild rodents and their fleas during work, hunting, or camping activities. Outbreaks of human plague are rare and typically occur in crowded urban settings associated with large increases of infected commensal rats (*Rattus rattus*) and their flea populations. Risk is year-round and restricted to focal areas. Enzootic foci have been reported primarily in remote, rural mountainous, or upland areas in Yunnan, Zhejiang, Sichuan, Gansu, and Qinghai Provinces and in Nei Mongol, Xizang (Tibet), and Xinjiang Uygur Autonomous Regions. Specific locations of known foci include Tongliao City (Nei Mongol Autonomous Region), Zhangye Prefecture (Gansu Province), Yushu and Haixi Autonomous Prefectures (Qinghai Province), the Songliao Plain on the border of Hebei Province, and Nei Mongol Autonomous Region east of Kangbao.

Rickettsioses, Tick-borne (Spotted Fever Group): Rickettsioses are transmitted by multiple species of hard ticks, including *Rhipicephalus* spp., which are associated with dogs. Other genera of ticks, such as *Ixodes, Dermacentor,* and *Amblyomma* are also capable of transmitting rickettsial pathogens. The disease risk is year-round and varies with location and latitude. The risk is year-round in the southern provinces of Yunnan, Guizhou, Guangxi (Autonomous Region), Hainan, and the southern parts of Guangdong.

Severe Fever with Thrombocytopenia Syndrome (SFTS): SFTS is a viral infection caused by a tick. The infectious agent is Banyangvirus in the order Bunyavirales, *Huaiyangshan banyangvirus*, a member of the Bhanja virus serocomplex, abbreviated SFTSV. SFTS deaths in China have been reported as recently as April-July 2020. SFTS cases have also been reported from Republic of Korea, Japan, Vietnam, and Taiwan.

Sindbis (and Sindbis-like) Fever: Viral diseases transmitted by a variety of *Culex spp*. mosquitoes found primarily in rural areas. Sindbis and Sindbis-like viruses are among the most geographically widespread of all arboviral diseases. They cause clinical illness like chikungunya. These viruses are maintained in bird-mosquito cycles in rural areas and occasionally cause limited outbreaks among humans. The disease is a debilitating febrile illness often accompanied by rash, typically requiring 1 to 7 days of supportive care and significant arthralgia (joint pain) can persist for several weeks or more in some cases.

Typhus, Flea-borne (Murine Typhus): Murine typhus is a bacterial disease caused by *Rickettsia typhi* or possibly *R. felis.* A person or animal becomes infected with typhus bacteria due to flea bites. The bacteria are found in the feces of some fleas. When a flea bites, it also defecates. If the person or animal then scratches the flea bite, some of the bacteria in the flea feces can enter the blood stream. People can also be infected by transferring the bacteria to their eye, nose, or mouth. Because rats (*Rattus rattus* and *R. norvegicus*) are the primary hosts for fleas, the potential distribution parallels that of common rats, which are present worldwide, often along coastal regions, extending inland variable distances. Wild rodents and their fleas also may carry the infection as well. Murine typhus is a debilitating febrile illness typically requiring 1 to 7 days of supportive care followed by return to duty. Fatalities are rare.

Typhus, Mite-borne (Scrub Typhus): The disease is transmitted by the larval stage of trombiculid mites (chiggers), which are typically found in areas of grassy or scrubby vegetation, often in areas which have undergone clearing, reforested areas, overgrown terrain, oil palm estates, and new settlements. In groups of personnel exposed to heavily infested focal areas ("mite islands"), attack rates could be very high. Foci have been identified in the following locations:

- Southern China: Fujian, Guangdong, Guizhou, Hainan, Hunan, and Zhejiang Provinces and Guangxi Autonomous Region;
- Central China: Anhui, Jiangsu and Sichuan Provinces and Xizang (Tibet) Autonomous Region; and
- Northern China: Heilongjiang, Jilin, Liaoning, and Shandong Provinces and Tianjin Municipality.

Aerosolized Dust or Soil/Water-contact diseases

Hantavirus Hemorrhagic Fever with Renal Syndrome: Hantavirus Hemorrhagic Fever with Renal Syndrome (HFRS); transmission to humans is associated with exposure to aerosolized virus excreted in the urine or feces of an infected rodent host. The disease risk is year-round, countrywide, and varies by location (see Figure 4). Elevated risk coincides with periods of increased rodent populations. In rural areas, risk usually is elevated from October through December and from May through July, associated with *Apodemus agrarius* (Asian striped field mouse). In urban areas, elevated risk exists from February through June, associated with *Rattus norvegicus* (Norway rat). Risk in rural agricultural areas is related to field mice, which carry *Hantaan* virus. Rats, which carry *Seoul* virus, are widely distributed in both rural and urban areas.

Soil-transmitted Helminths: Soil-transmitted helminths (STH) are intestinal worms, including *Ascaris* roundworms, whipworms, hookworms, and *Strongyloides* roundworms, that infect humans through contaminated soil. STHs are widely distributed throughout the developing world in areas where sanitation is poor, particularly in tropical areas.

Leptospirosis: Rodents, domestic livestock, and other animals are reservoirs for the causative agent (a spirochete bacterium) and shed the organism in their urine. Risk is year-round,

countrywide, and varies with elevation. Risk is year-round in southern China, with peak incidence from July to October. More than 90% of cases in central and northern China occur during the warmer months from April to November. Chinese research institutes report that the Chang Jiang River basin is the major leptospirosis-infected area of China.

Schistosomiasis: Operations or activities that involve extensive water contact may result in personnel and military working dogs (MWDs) becoming temporarily debilitated with schistosomiasis (in some locations). Parasitic worms (flukes) found in fresh water penetrate the skin and develop in the blood vessels. Female worms shed eggs into the bloodstream, which travel throughout the body. Clinical signs are the result of the body's reaction to the eggs. Humans are the primary reservoir host for *Schistosomes*; humans shed schistosomes' eggs in urine or feces.

Animal-contact diseases

Rabies: Rabies is transmitted by exposure to virus-laden saliva of an infected animal, typically through bites. Rabies risk is year-round, countrywide, and is assessed as well above U.S. levels due to ineffective control programs; personnel bitten by potentially infected reservoir species may develop rabies in the absence of appropriate prophylaxis. Feral dogs, feral cats, bats and wild carnivores should be regarded as rabid unless proven otherwise.

Q Fever: Exposure occurs primarily via the respiratory route, with an infectious dose as low as a single bacterium (*Coxiella burnetii*). Infective aerosols are inhaled in areas contaminated by infected livestock (cattle, sheep, and goats). Significant outbreaks can occur in personnel with heavy exposure to barnyards or other areas where animals are kept. Unpasteurized milk may also transmit infection. Risk is year-round and distributed primarily in rural areas.

Table 1: Disease Summaries

Food and Water-borne Diseases								
Disease	**Operational Risk**	**Risk Period**	**Severity**	**Primary Vector**	**Pathogen**	**Typical Incubation**	**Risk Distribution**	**Prevention**
Diarrhea - bacterial	High	Year round	Mild	Filth Flies	Various bacterial pathogens	1-3 days	Countrywide	Sanitation
Vector-borne Diseases								
Disease	**Operational Risk**	**Risk Period**	**Severity**	**Primary Vector**	**Pathogen**	**Typical Incubation**	**Risk Areas**	**Prevention**
Crimean-Congo Hemorrhagic Fever	High	Year-round, varies with latitude	Very Severe	*Hyalomma asiaticum (hard tick)*	Nairovirus (Bunyavirus)	3- 7 days	Rural village populations	Repel and kill ticks
Japanese encephalitis	High	Year-round, varies with latitude	Very Severe	*Culex* spp.	Japanese Encephalitis Virus; (Flavivirus)	5-15 days	Primarily rural	Vaccine and Mosquito habitat reduction and bite prevention
Dengue Fever	Intermediate	Year-round, varies with latitude	Moderate	*Aedes aegypti, Aedes albopictus*	Dengue Virus (Flavivirus)	4-7 days	Urban and densely populated areas; risk low in large, modern cities	Mosquito habitat reduction and bite prevention
Chikungunya	Intermediate	Year-round, varies with latitude	Moderate	*Aedes aegypti, Aedes albopictus*	*Chikungunya Virus (Togavirus)*	3-7 days	Urban and densely populated areas	Mosquito habitat reduction and bite prevention
Malaria	Intermediate	Year-round, varies with latitude	Moderate	*Anopheles* spp.	*Plasmodium falciparum, Plasmodium. vivax*	7-14 days	Primarily rural	Mosquito habitat reduction and bite prevention
Rickettsioses, tickborne (spotted fever group)	Intermediate	Year-round, varies with latitude	Moderate	*Rhipicephalus* spp., *Ixodes* spp.	*Rickettsia*	2-14 days	Primarily rural	Repel and kill ticks
Typhus - mite borne (scrub typhus)	Intermediate	Year-round, varies with latitude	Moderate	Trombiculid mites particularly *Leptotrombidium deliense*	*Orientia tsutsugamushi*	10-12 days	Focal areas in southern, central, and northern China	Repel mites

Vector-borne Diseases								
Disease	**Operational Risk**	**Risk Period**	**Severity**	**Primary Vector**	**Pathogen**	**Typical Incubation**	**Risk Areas**	**Prevention**
Plague	Intermediate	Year-round	Severe	*Xenopsylla cheopis and other flea spp.*	*Yersenia pestis*	1-7 days	Focal areas in remote, rural mountainous, or upland areas	Decrease commensal rat populations
Lyme disease	Intermediate	Year-round, varies with latitude	Moderate	Nymphal stage of *Ixodes* ticks	*Borrelia burgdorferi*	7-10 days	Primarily rural	Repel and kill ticks
Tick-borne encephalitis (TBE)	Intermediate	Year-round, varies with latitude	Very Severe	Multiple species of hard ticks	*Several Flaviviruses*	7-14 days	Primarily rural	Repel and kill ticks
Sindbis (and Sindbis-like viruses)	Low	Year-round, varies with latitude	Moderate	*Culex* spp. mosquitoes	*Alphavirus,* (Togaviridae)	3-11 days	Rural Southern provinces	Mosquito habitat and bite prevention
Typhus – Murine (flea-borne)	Low	Year-round	Moderate	*Xenopsylla cheopis* (Oriental rat flea)	*Rickettsia typhi*	12 days	Rat infested rural villages	Decrease commensal rat populations
Leishmaniasis	Low	Seasonal (Apr–Oct)	Mild - Severe	*Phlebotomus* sand flies	*Leishmania* trypanosomes	7-180 days	Focal areas	Sand fly bite reduction
Aerosolized Dust or Soil/Water-contact Diseases								
Disease	**Operational Risk**	**Risk Period**	**Severity**	**Primary Vector**	**Pathogen**	**Typical Incubation**	**Risk Areas**	**Prevention**
Hantavirus (HFRS)	High	Year-round	Very Severe	Various Rodents	Orthohantaviruses	14-28 days	Countrywide	Minimize contact with rodents
Soil-transmitted helminths	Intermediate	Year-round	Mild	NA	Primarily *Ancylostoma duodenale* and *Necator americanus*	Varies	Primarily rural	Avoid bare skin contact with water and soil
Leptospirosis	Intermediate	Year-round, varies with latitude	Moderate	NA	*Leptospira* bacteria	4-19 days	Freshwater bodies of water such as rivers, lakes, streams, or irrigated fields.	Avoid water contact
Schistosomiasis	Intermediate	Year-round, varies with latitude	Moderate	NA	Parasitic worms (flukes) -	14-42 days	Freshwater bodies of water such as rivers, lakes, streams, or irrigated fields.	Avoid water contact

Animal-contact Diseases								
Disease	**Operational Risk**	**Risk Period**	**Severity**	**Primary Vector**	**Pathogen**	**Typical Incubation**	**Risk Areas**	**Prevention**
Rabies	Intermediate	Year-round	Very Severe	Mammals	*Rabies lyssavirus (*Rhabdovirus*)*	21-56 days	Countrywide	Avoid contact with dogs, cats, and other mammals
Q-fever	Intermediate	Year-round	Moderate	Livestock	*Coxiella burnetii*	14-21 days	Primarily rural	Avoid contact with livestock

Disease Information

Food and Water-borne Diseases

Diarrheal Disease

Background

Sanitation varies with location but typically is well below U.S. standards. While some modern coastal cities such as Beijing and Shanghai approach Western sanitation standards, local food and water sources (including ice) may be contaminated with pathogenic bacteria, parasites, and viruses to which most U.S. service members have little or no natural immunity. Diarrheal diseases may temporarily incapacitate a high percentage of personnel within days if contaminated food, water, or ice is consumed. Hepatitis A and typhoid fever can cause prolonged illness in a smaller percentage of unvaccinated personnel. In addition, although not specifically assessed in this document, significant outbreaks of viral gastroenteritis (e.g., norovirus) and food poisoning (caused by e.g., *Bacillus cereus*, *Clostridium perfringens*, and *Staphylococcus*) may occur.

Distribution

In general, bacterial agents such as enterotoxigenic *Escherichia coli*, *Campylobacter*, *Shigella*, and *Salmonella* are the most common causes of traveler's diarrhea wherever sanitary conditions are significantly below U.S. standards. The risk is distributed evenly throughout the country.

Vector Ecology

Filth flies have been implicated in the direct and indirect mechanical transmission of several pathogens responsible for human diseases, especially those causing diarrheal illness. Mechanical transmission is the transfer of pathogens from one location to another without the pathogen completing part of its lifecycle in the temporary host. Thus, mechanical transmission of disease organisms is facilitated by adult filth flies' habit of walking and feeding on materials that tend to be contaminated, then doing the same on food to be consumed by humans. Regurgitating and defecating while feeding also increase the potential for transmission of pathogens by flies.

Over 100 pathogens that can cause human disease are known to contaminate filth flies. The role that filth flies play in transmitting pathogens to humans, and to what extent this transmission leads to disease, depends on the pathogen and associated environmental factors. In some instances, transmission by flies may be significant, while in other instances it is nonexistent. Just because a pathogen is recovered from a fly does not mean that successful transmission is possible. Pathogens include bacteria (*Aeromonas* spp., *Campylobacter* spp., *Escherichia coli*, *Salmonella* spp., *Shigella* spp., *Vibrio parahaemolyticus*, *Yersinia enterocolitica*) and protozoa (*Cryptosporidium* spp., *Entamoeba histolytica*, *Giardia lamblia*). Rotavirus and enteric adenoviruses have been reported as causes of gastroenteritis among indigenous children and newly deployed US forces.

Disease Prevention

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.

Vector-borne Diseases

Vector-borne diseases are an important type of infectious disease in China. Ecological conditions support populations of arthropod vectors, including mosquitoes and ticks, which vary from year-round in the south to approximately May through September in the north. Japanese encephalitis, Dengue fever, Crimean-Congo hemorrhagic fever (also known as Xinjiang hemorrhagic fever virus, XHFV), and tick-borne encephalitis (TBEV) are the four principal diseases transmitted by arthropods of public health importance in mainland China. In 2018, Scrub typhus, hemorrhagic fever with renal syndrome (HFRS), and dengue contributed to 85.08% of all cases. Japanese encephalitis (JE), severe fever with thrombocytopenia syndrome (SFTS), and Hantavirus Fever with Renal Syndrome (HFRS) accounted for 95.76% of all fatalities.

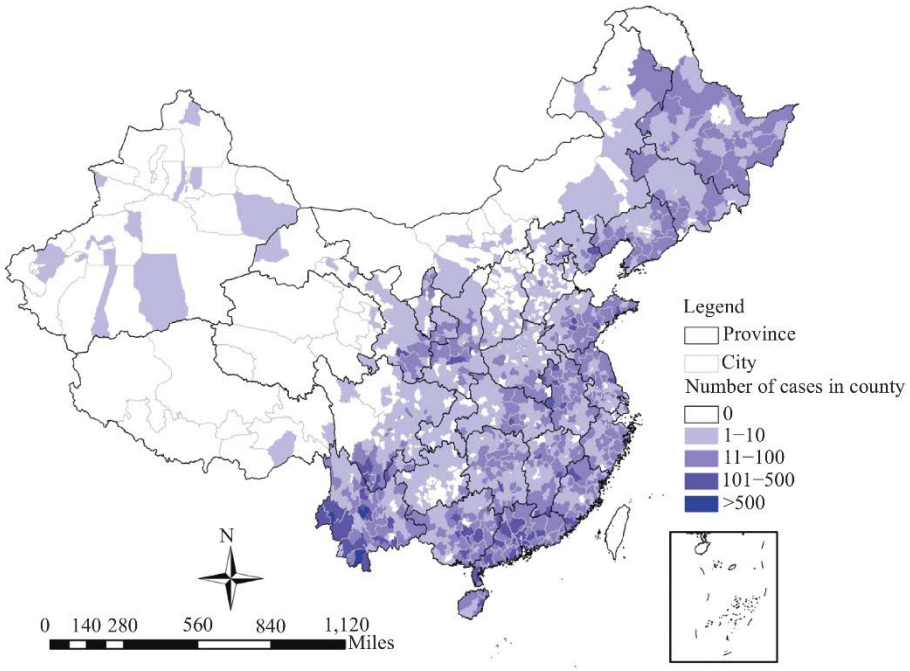


Figure 2. Spatial distribution of overall cases of vector-borne diseases in Mainland China, 2018 (Liu and Goa, 2020).

Mosquito-borne diseases

Japanese Encephalitis

Background

Japanese encephalitis (JE) is caused by a Flavivirus (family Flaviviridae) which is closely related to St. Louis encephalitis virus. Many infections are asymptomatic or produce a mild systemic illness characterized by fever, headache or aseptic meningitis. Serological studies indicate a ratio of inapparent to apparent infections as high as 300 to 1. The incubation period is 5 to 15 days. Severe infections are marked by acute onset, high fever, extreme headache, and vomiting. Inflammation of the brain, spinal cord and meninges can cause stupor, tremors, convulsions (especially in infants), spastic paralysis, coma and death. Case fatality rates can be as high as 40%. Fatal cases result in coma and death within 10 days. Based on past epidemics, approximately 25% of clinical cases are rapidly fatal, 50% lead to permanent neurological or psychiatric sequelae, and 25% resolve within 1 to 2 weeks. Neurological impairment is most severe in infants. No specific therapy is effective and treatment is primarily supportive. The disease is widespread throughout China (Figure 3~~2~~) and caused 1804 cases with 152 deaths in 2018 (Liu and Gao, 2018)

Distribution

JE is enzootic countrywide except for Qinghai Province, and Xinjiang and Xizang Autonomous Regions. The highest risk of transmission occurs in central and eastern China, where rice fields and pig rearing coexist. Enzootics occur in the warm rainy months, usually May through September, but transmission may occur year-round in tropical southern provinces. There is low risk in urban areas. Consequently, JE does not occur in urban Macau or Hong Kong, although about a dozen cases have been reported in the last 10 years from rural areas of the New Territories, i.e., that part of the Hong Kong Special Administrative Region comprising the northern portion of the Kowloon Peninsula from Mirs Bay (Dapeng Wan) on the east to Deep Bay (Shenzhen, or Houhai, Wan), an inlet of the Pearl River Delta, on the west, including Lantau (Lantao) and other islands.

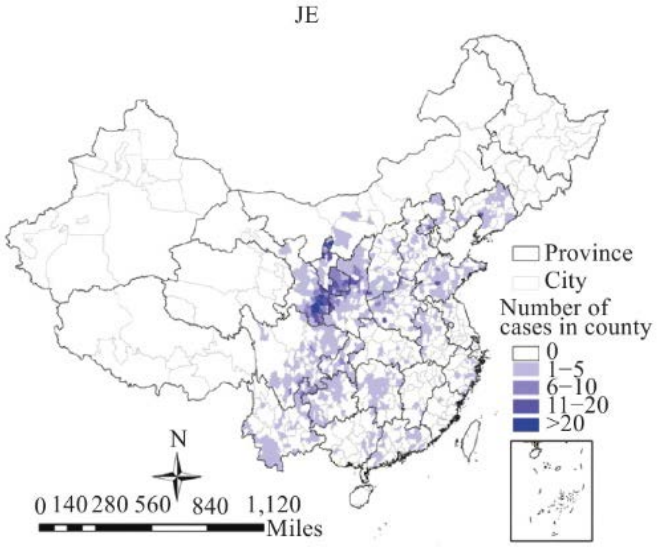


Figure 3. Spatial distribution of Japanese Encephalitis in Mainland China, 2018 (Liu and Gao, 2020).

Vector Ecology

In China, the principal vector is *Cx. tritaeniorhynchus,* with secondary vectors including *Cx. pipiens pallens* and *Aedes albopictus*. A few rare isolates of JEV have been made from *Armigeres obturbans* and *An. hyrcanus*, but these species are probably insignificant vectors. Other vector species that occur in China are *Cx. vishnui* and *Cx. pseudovishnui*, although their relative importance is unclear.

Culex tritaeniorhynchus is the most important JE vector in most parts of East Asia. It occurs in large numbers during the summer months of July and August, especially in rice growing areas, and feeds readily on amplifying hosts such as pigs and wading birds (i.e., herons and egrets), as well as humans. It also is strongly attracted to cattle. This species is both endophagic and exophagic, but endophilic during the cool months in northern parts of the region. In warmer months, adults tend to feed outdoors. Adults begin feeding early in the evening, and continue feeding throughout the night, with decreasing activity after 0200 hours. They are moderately strong fliers that will travel an average of 3 km for a bloodmeal. However, laboratory studies using flight mills indicate that this species can fly as far as 20 km. *Culex tritaeniorhynchus* deposits egg rafts on the water surface that contain about 75 to 150 eggs each. They are deposited 3 to 4 days following a bloodmeal. Eggs hatch 2 to 4 days after deposition. Common oviposition sites include rice fields, water troughs, irrigation spillovers and ditches, and undisturbed ground pools. Rice fields are generally colonized soon after the planting of the paddy, resulting in one large synchronous generation of adults over the normal six weeks of planting activity. Larvae of *Cx. tritaeniorhynchus* generally prefer lightly shaded ground pools with low concentrations of organic matter and some emergent vegetation. Larval development requires 7 to 9 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 2 days. Development generally ceases below 16°C. In mid-latitudes, adults are not active and diapause from late November to early February. In the northernmost part of its range, the species may completely disappear during winter and have to be recolonized by mosquitoes migrating from mid-latitudes the following spring. In southern areas of China and Taiwan, peak abundance occurs as early as June, with a possible secondary peak in September or October. *Culex tritaeniorhynchus* overwinters as larvae or adults. Increasing irrigation and cultivation of rice in many areas of China have contributed to the spread and abundance of this species. Transovarial transmission of JEV has been demonstrated in this species

Vector Surveillance and Suppression

Most *Culex* vectors of JEV are readily collected in light traps. Animal-baited traps can collect large numbers of zoophilic species. Adults can also be collected with an aspirator from animal sheds and other resting places. JEV can be detected in mosquitoes before outbreaks in humans occur. Testing sentinel pigs weekly for seroconversions has been used successfully by public health workers to detect JEV activity in many endemic areas. Implementation of mosquito control is based on the occurrence of pig seroconversions, which generally precede JE outbreaks in the human population by 1 or 2 weeks.

Control of JE vectors with insecticides over large areas is impractical, environmentally unacceptable and prohibitively expensive. Application of insecticides to rice paddies may dramatically reduce larval populations, but they usually recover within 1 week. Some success in interrupting JEV transmission has been achieved by applying residual insecticides to the interior

walls of houses, but studies in China have shown that this is not as effective as the use of bed nets impregnated with a pyrethroid. Insecticide resistance has become widespread in many vector species (see Appendix B, Pesticide Resistance in East Asia). ULV aerosols may be useful in reducing adult populations during periods of epidemic JEV transmission. Long-term control is best achieved by environmental management of breeding sites, such as intermittent irrigation of rice paddies or the use of larvivorous fish. Protection of military personnel is best achieved by use of the personal protective measures and vaccination.

Chikungunya

Background

Disease produced by the chikungunya virus (Alphavirus, family Togaviridae) is characterized by sudden onset fever, rash, nausea, vomiting, and severe joint pains that may persist as a recurrent arthralgia for months or even years. The incubation period is 3 to 7 days, and the acute illness lasts 3 to 5 days. Minor hemorrhages have been attributed to chikungunya virus disease in India and Southeast Asia. Convalescence is often prolonged. Recovery is usually complete followed by lifelong immunity. Asymptomatic infections are common, especially in children, among whom clinical disease is rare. Chikungunya can be differentiated from dengue in that pain is predominately located in the joints rather than the muscles, and the febrile period is shorter and usually not biphasic, i.e. exhibiting two separate episodes or waves of fever.

Distribution

Transmission and outbreaks are intermittent and unpredictable. Risk is year-round in the southern provinces of Yunnan, Guizhou, Guangxi (Autonomous Region), Hainan, and the southern parts of Guangdong. Further north in Fujian, Zhejiang, and Shanghai, the transmission season progressively shortens to approximately April through October. Although transmission is intermittent and unpredictable, risk distribution likely parallels that of dengue with risk highest in urban and other densely populated areas, lowest in sparsely populated areas (see dengue map).

Vector Ecology

Chikungunya is transmitted primarily by *Aedes aegypti* and *Aedes albopictus* mosquitoes. In Africa, monkeys and other mammals are sylvatic reservoirs. In Asia, no sylvatic reservoirs have been definitively identified, although antibodies to chikungunya virus have been found in two primate species. Humans become the primary reservoir during outbreaks. *See Dengue section for additional information.*

Vector Surveillance and Suppression

See Dengue section for information about vector surveillance and suppression.

Dengue Fever

Background

Dengue is an acute febrile disease characterized by sudden onset fever that lasts 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 4 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 occur throughout Southeast Asia and the Pacific, and 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.

Distribution

The risk is year-round in the southern provinces of Yunnan, Guizhou, Guangxi (Autonomous Region), Hainan, and the southern parts of Guangdong. Further north in Fujian, Zhejiang, and Shanghai, the transmission season progressively shortens to approximately April through October. Risk is highest in urban areas and other densely populated areas and is lowest in sparsely populated areas. In China, risk is typically very low in more modern, major cities including Hong Kong and Shanghai.

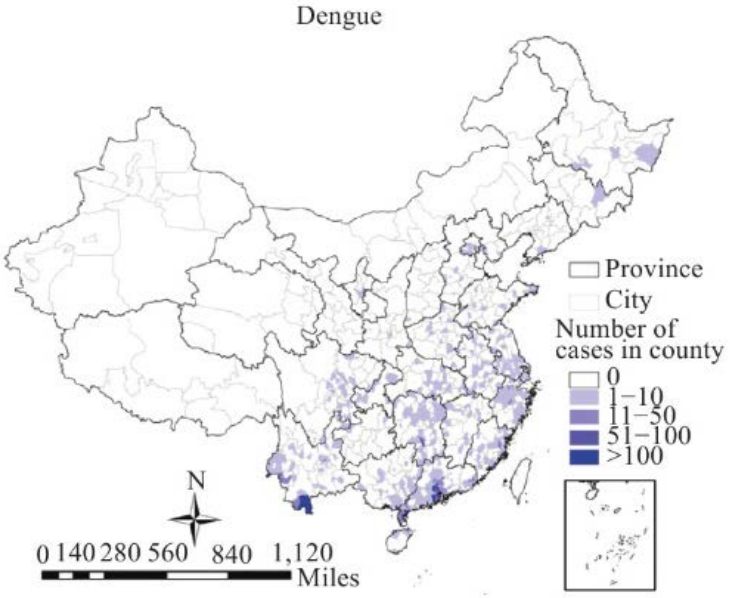


Figure 4. Spatial distribution of Dengue in Mainland China, 2018 (Liu and Gao, 2020).

Vector Ecology

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 8 to 10 days after an infective bloodmeal and can transmit the virus for life. Dengue virus replicates rapidly in the mosquito at temperatures above 25°C.

Aedes aegypti, the primary vector of dengue, is widespread throughout East Asia. This species is more common in cities or in villages than in rural areas. It is very abundant in slums and shantytowns, where drinking water is stored in tanks or jars and there are numerous artificial containers. *Aedes aegypti* deposits its eggs singly or in small groups of 2 to 20 above the water line of its habitat. Eggs may withstand desiccation for 3 months or more. Larvae emerge after eggs have been submerged for 4 or more hours. *Ae. aegypti* larvae live in artificial water containers, including flowerpots, cisterns, water jugs, tires, and flooded basements. The most

common breeding sites during surveys taken since 1988 in Taiwan were ornamental containers (39%), water storage containers (30%), and discarded containers (25%). Larvae develop quickly in warm water, maturing to the pupal stage in about 9 days. Pupae remain active in the water container until adult emergence, 1 to 5 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 5 km per hour.

Aedes aegypti prefers human hosts and feeds primarily around human habitations. It is a diurnal feeder and readily enters homes. This species 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 moderately high, typically biting in the morning, and then again to a lesser extent towards evening when temperatures start to cool off again. 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 the virus. *Aedes aegypti* rests in cool, shaded areas within dwellings, often in closets, under tables, or in sheds. Similarly, it rests outdoors in shaded areas among trees, shrubs, and structures.

Aedes albopictus is second only to *Ae. aegypti* in importance as a vector of dengue. *Aedes albopictus* is more common in rural than urban areas. Its larval and adult feeding habits are like those of *Ae. aegypti*, but it 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* and may feed on oxen, dogs and pigs. *Aedes albopictus* does not readily feed on birds. *Aedes albopictus* most often occurs in rural, partially forested areas, particularly along forest fringes, where it may be present in large numbers. It is generally absent from the interiors of deep forests or jungles, although it is the dominant species of mosquito in bamboo forests of Taiwan and China. Eggs are deposited singly or in small numbers above the water line and hatch after being flooded for 1 to 7 days, depending on the state of embryo development. *Aedes albopictus* is less likely than *Ae. aegypti* to breed in indoor containers. The larval development time varies from 5 days to 3 weeks, depending on temperature. Adults emerge 1 to 5 days after pupation. Females feed every 3 to 5 days for the duration of their life, which lasts from 1 to 4 weeks. Females fly close to the ground and generally not further than 100 m from their breeding sites. They do not fly in winds over several km per hour. Adults may also feed on nectar from plants. Autogeny occurs in this species, although usually only 2 to 4 eggs are produced in this manner. Peak feeding periods outdoors are generally early morning and late afternoon. Adults usually feed outdoors and rest outdoors in undergrowth. However, indoor feeding and resting behavior also occur.

Vector Surveillance and Suppression

A number of fan-operated traps designed to capture *Ae. aegypti* adults take advantage of the propensity of this species to be attracted to dark objects (US CDC, 2017). The Fay-Prince trap has been widely used, but it is heavy and bulky, making it difficult to use in sufficient numbers to obtain reliable estimates of mosquito abundance. Currently the most commonly used adult traps for *Ae. aegypti* and *Ae. albopictus* are BG-Sentinel traps, and a variety of gravid traps such the CDC-Autocidal Gravid Ovitrap, the CDC-AGO (US CDC, 2017). The BG-Sentinel traps use a combination of attractive visual and olfactory cues. They have the advantage of being collapsible and light. BG-Sentinel traps are more effective in capturing *Ae. aegypti* than CDC backpack aspirators, and also collect adult females in all physiological states (US CDC, 2017). These traps are also effective for collecting *Ae. albopictus* (US CDC, 2017). The efficiency of BG-Sentinel traps can be increased by baiting them with lures, e.g., CO^2, BG-Lure®). A number

of recently developed traps use similar principles of attraction as ovitraps to attract and capture gravid females. These traps use either funnels or sticky boards to prevent captured mosquitoes from escaping. The advantage of gravid traps is that they are considerably cheaper and easier to operate compared to BG-Sentinel traps (US CDC, 2017). Gravid female mosquitoes can also be lured to traps baited with an oviposition medium and captured using sticky glue while attempting to lay eggs, for example, the CDC-AGO trap mentioned above. The use of three AGO traps per home in more than 85% of houses in neighborhoods in southern Puerto Rico has demonstrated sustained and effective reductions of *Ae. aegypti* populations of 80% (US CDC, 2017).

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 1 minute, is recorded. Resting collections entail a 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 in each house 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 5, and emergency vector control is indicated when the index exceeds 100. Adult egg-laying activity can be monitored using black oviposition traps that container-breeding *Aedes* readily utilize. The number of eggs laid in the ovitraps provides a relative indication of the abundance of dengue vectors. Ovitraps are especially useful for the early detection of new infestations in areas from which dengue vectors had been eliminated.

No vaccine and no specific treatment exists for dengue, so 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. However, lack of efficiency in the last two decades has necessitated reevaluation of the strategies for the prevention and control of dengue. More reliance is now being placed on community-based integrated approaches to *Ae. aegypti* control, with greater emphasis on larval source reduction. The individual Soldier can best prevent infection by using personal protective measures during the day when vector mosquitoes are active

Malaria

Background

Human malaria is caused by any of 4 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 kidney and liver failure, cerebral involvement and coma. Case fatality rates among children and nonimmune adults exceed 10% when not treated. The other human malarias, *P. vivax*, *P. malariae* and *P. ovale*, are not life-threatening except in the young, the 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 malaria infection. 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.

Distribution

The 2018 World Malaria Report, published by the World Health Organization (WHO), indicates that none of the country's 1.4 billion people live in active foci and there were zero locally acquired cases reported in China in 2017. According to the 2016 World Malaria Report, malaria incidence rates in China decreased by nearly 100 percent from 2010 to 2015. Malaria is present at low levels across a wide expanse of rural China. The highest incidence occurs in Anhui, Hainan, and Yunnan Provinces. Risk is essentially zero in urban areas. *Plasmodium falciparum* occurs primarily if not exclusively in Hainan and Yunnan Provinces. Because of its international borders with Myanmar, Laos and Vietnam, Yunnan Province has many imported cases of malaria, including a high proportion of *P. falciparum*.

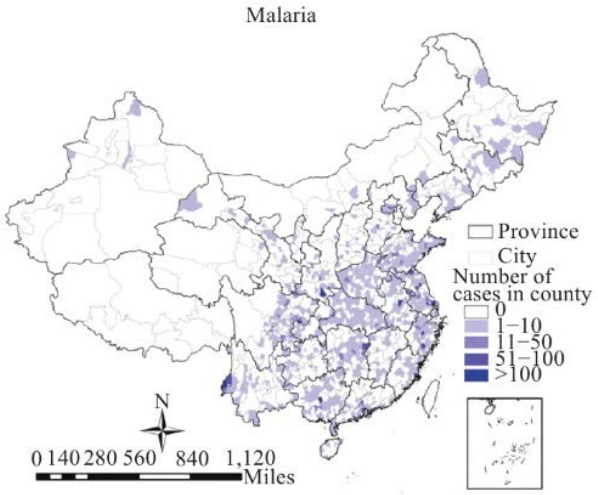


Figure 5. Spatial distribution of Malaria in Mainland China, 2018 (Liu and Gao, 2020).

Vector Ecology

Malaria is transmitted by *Anopheles* spp. that typically bite at night, breed in a variety of locations including streams, marshes, and lagoons and are usually associated with rural environments.

Anopheline vectors of malaria occur throughout East Asia, although transmission occurs primarily below 33° N latitude. The primary vector species in northern China and the rice-growing regions of the plains is *An. sinensis*. *An. messeae* also transmits P. vivax in northern China Between 25° N and 33° N latitude. *An. sinensis* vectors *P. vivax*, while *An. lesteri anthropophagus* transmits *P. vivax* and, to a lesser degree, *P. falciparum*. *An. minimus* occurs widely in East Asia, from west-central to southeastern China (including Hong Kong). *An. dirus* is an important vector of both *P. falciparum* and *P. vivax* in China, but its distribution is limited primarily to Yunnan Province and Hainan Island. Secondary vectors in China include members of the *An. maculatus* group, *An. kunmingensis*, An. *jeyporiensis*, *An. sinensis*, and *An. philippinensis*. *Anopheles kunmingensis* also occurs at altitudes above 1,600 m.

Anopheles sinensis, a member of the *An. hyrcanus* group, is the most widespread malaria vector in East Asia, occurring in virtually all countries and areas where malaria is transmitted. However, it is generally considered to be a poor vector since it is primarily zoophilic and exophilic. Its role as a vector is limited to areas where it is most numerous and where human density is also high. *Anopheles sinensis* breeds in rice fields and exhibits population peaks after flooding of the paddies in March and again in September to October. It is a major vector in rice growing regions in the plains of China. Its biting activity increases through the evening, reaches a peak at midnight, then decreases toward dawn. Larvae also occur in ditches, swamps and seepage areas of rice paddies. This species generally has a flight range of 1 km or less

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.

Application of residual insecticides to the interior walls of buildings (indoor residual spraying; IRS) 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 control measures (e.g., larvivorous fish) can reduce populations of larvae at their aquatic breeding sites before adult mosquitoes emerge and disperse.

Sanitary improvements, such as filling and draining areas of impounded water to eliminate breeding habitats, should be undertaken to the greatest extent possible. Rice needs considerable irrigation for high yields, and this limits the possibilities for manipulating water to control mosquitoes. Well-designed drainage or flushing and careful timing of intermittent irrigation can control mosquito breeding but must be practical and economical to be accepted by farmers. Instead of draining, marshes can be excavated to form deep permanent impoundments with well-defined vertical banks that are unsuitable habitats for mosquito larvae. Other methods of source reduction can be utilized.

Service members can best protect themselves from malaria by taking malaria prophylaxis as prescribed, and through personal protective measures such as dermal repellents. Bed nets should be used while sleeping and can be treated with permethrin.

Drug resistance

According to the 2018 World Malaria Risk Chart, produced by the International Association for Medical Assistance for Travelers (IAMAT), *P. falciparum* resistance to chloroquine, mefloquine hydrochloride and sulfadoxine-pyrimethamine (Fansidar) was reported in rural areas in Yunnan province and the southeastern tip of Tibet. According to the 2015 Risk Chart, chloroquine-resistant *P. falciparum* was reported in parts of Yunnan, Guangxi, Guangdong, and Hainan Provinces. Yunnan and Hainan Provinces also reported Fansidar-resistant *P. falciparum*.

Sindbis (and Sindbis-like) Fever

Background

Sindbis and Sindbis-like viruses are among the most geographically widespread of all arboviral diseases. They cause clinical illness similar to chikungunya. These viruses are maintained in a bird-mosquito cycle in rural areas and occasionally cause limited outbreaks among humans.

Distribution

Risk is year-round in the southern provinces of Yunnan, Guizhou, Guangxi (Autonomous Region), Hainan, and the southern parts of Guangdong. The transmission season shortens progressively at higher latitudes, lasting from approximately April through October in central China, and approximately April through September in the northern provinces, including Xinjiang. Conditions at elevations above approximately 2,500 meters in the Tibetan plateau typically are too cold for most vector activity.

Vector Ecology

Sindbis virus is transmitted by a variety of *Culex* spp. mosquitoes found in primarily rural areas. A wide range of wild and domestic vertebrate species are susceptible to infection with Sindbis virus. Evidence implicates bird feeding mosquitoes of the genus *Culex* as the vectors of Sindbis virus in enzootic and human infections. Its status in East Asia is unclear. A Sindbis-like virus was isolated from a pool of *Anopheles* mosquitoes collected in Xinjiang, China.

Disease Prevention

Protection of military personnel is best achieved by use of the personal protective measures.

Tick-borne Diseases

Crimean-Congo Hemorrhagic Fever

Background

Crimean-Congo Hemorrhagic Fever (CCHF) is a zoonotic disease caused by a tick-borne virus of the genus Nairovirus, 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 3 to 10 days. CCHF may be clinically confused with other hemorrhagic infectious diseases. While rodents and livestock may be reservoirs for the virus, humans are the only natural host of CCHF virus in which disease has been confirmed. The ratio of apparent to inapparent infections suggests that 1 of every 5 persons infected develops clinical illness.

Distribution

Risk of tick-borne transmission is year-round in the southern provinces of Yunnan, Guizhou, Guangxi, Hainan, and the southern parts of Guangdong. The transmission season for ticks shortens progressively at higher latitudes, lasting from approximately April through October in central China, and approximately April through September in the northern provinces, including Xinjiang. Conditions at elevations above approximately 2,500 meters in the Tibetan plateau typically are too cold for most vector activity. Risk of transmission from animal contact is present year-round.

Figure 6. Distribution of CCHF in mainland China (Gao et al., 2010).

Vector Ecology

Multiple tick species transmit CCHF and act as reservoirs for the virus, particularly *Hyalomma*, *Boophilus*, or *Rhipicephalus* spp. Tick vectors can be found in a variety of rural habitats. In addition to ticks, reservoirs may include hares, birds, rodents, and possibly other species. Domestic livestock including sheep, goats, and cattle may act as amplifying hosts. CCHF virus has been isolated from *Hyalomma asiaticum* in the Xinjiang Autonomous Region. This very large 3-host tick (engorged weights of 1.5 g have been recorded in females) is an inhabitant of deserts and steppes in the northern and western parts of China. Adult *Hy. asiaticum* may seek hosts as far as 500 m from where the nymphs have detached and molted, although they normally quest for hosts within 75 m of their place of detachment. This species is very tolerant of desiccation, but larvae and nymphs may remain in rodent burrows during hot summer days and seek a host only during the cooler early morning hours. *Hyalomma asiaticum* can survive loss of body water up to 50% before dying. During the cooler months, they seek hosts throughout the day. This species is also resistant to starvation and can survive over a year without a bloodmeal. Larvae feed for 7 to 8 days, while nymphs and adults feed about 9 days and 6 days, respectively. Both transstadial and transovarial transmission of CCHF virus occurs efficiently in *Hy*. *asiaticum*.

Vector Surveillance and Suppression

Military personnel should use personal protective measures to prevent tick bites. 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. Serological surveys of domestic animals are the most practical and economical surveillance systems for CCHF virus. Sheep, goats and cattle have exhibited high antibody prevalence to the virus in areas where human disease has been documented.

Lyme Disease

Background

Lyme infections, caused by several species of *Borrelia* spirochetes, typically occur as sporadic cases or clusters of cases. People are infected most often by the bite of a tick (nymphal stage), usually in late spring or early summer, and less frequently by adult female ticks, which feed mostly in late fall but also in the winter and early spring. Treatment in the late stages of Lyme disease can be difficult, and delayed treatment or chronic infection can lead to debilitating sequelae. Early recognition and treatment are critical.

Distribution

Risk is year-round in the southern provinces of Yunnan, Guizhou, Guangxi (Autonomous Region), Hainan, and the southern parts of Guangdong. The transmission season shortens progressively at higher latitudes, lasting from approximately April through October in central China, and approximately April through September in the northern provinces. Conditions at elevations above approximately 2,500 meters in the Tibetan plateau typically are too cold for most vector activity.

Vector Ecology

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, Europe and Japan, 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 strain has been found in ticks as well as vertebrate reservoirs. Spirochetes can be passed transstadially but are seldom passed transovarially by female ticks.

Vector Surveillance and Suppression

Large-scale application of pesticides to control ticks is usually impractical and may be environmentally unacceptable on 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. Military personnel should use personal protective measures to prevent tick bites. Frequent self-examination and removal of ticks are important.

Rickettsioses, Tickborne (spotted fever group)

Background

Worldwide, the spotted fever group (SFG) of tick-borne rickettsioses comprises a wide variety of clinically similar subtypes, including African tick bite fever, Astrakhan fever, Boutonneuse fever (Mediterranean spotted fever), India tick typhus, Kenya tick typhus, North Asian tick fever, Rocky Mountain spotted fever, and Queensland tick typhus. Most human cases occur as sporadic cases; clusters of cases occasionally occur. Outbreaks rarely occur but may be associated with increased tick contact.

Distribution

The risk is year-round in the southern provinces of Yunnan, Guizhou, Guangxi (Autonomous Region), Hainan, and the southern parts of Guangdong. The transmission season shortens progressively at higher latitudes, lasting from approximately April through October in central China, and approximately April through September in the northern provinces. Conditions at elevations above approximately 2,500 m in the Tibetan plateau typically are too cold for most vector activity. Although rural areas generally provide the most suitable tick habitat, significant green spaces within urban and periurban areas could also support tick-borne transmission. Dogs carrying infected ticks may introduce risk from rural areas into urban or periurban areas.

Vector Ecology

Rickettsioses are transmitted by multiple species of hard ticks, including *Rhipicephalus* spp., which are associated with dogs. Other species of ticks, including *Ixodes* are also capable of transmitting rickettsial pathogens in this group. These pathogens are maintained in ticks by transovarial and transtadial transmission. Dogs, rodents, and other animals also can serve as reservoirs. Animal infections are usually subclinical, but disease in rodents and dogs has been observed.

Vector Surveillance and Suppression

Military personnel should use personal protective measures to prevent tick bites. Frequent self-examination and removal of ticks are important.

Severe Fever with Thrombocytopenia Syndrome (SFTS)

Background

SFTS is a viral infection caused by a tick. The infectious agent is Banyangvirus in the order Bunyavirales (Yu et al., 2011), *Huaiyangshan banyangvirus* (International Committee on Taxonomy of Viruses, 2018), a member of the Bhanja virus serocomplex (Matsuno et al., 2013), abbreviated SFTSV. It was first described from cases in central and northeast China in 2009, where it was isolated from patients who presented with fever, thrombocytopenia, leukocytopenia, and multiorgan dysfunction (Yu et al., 2011). SFTS is a serious public health problem in China in that it poses a significant threat to residents living in rural areas, and gives rise to panic (Ding et al., 2013). In China, SFTS was first identified from a 2009 outbreak that had an unusually high initial case fatality rate of 30% (Ding et al., 2013). In the 2009 cases, presence of the virus was confirmed in 171 patients from six central and northeastern provinces. Nearly all cases occurred from May to July and involved farmers living in wooded and hilly areas and working in fields before onset of the disease. The virus was detected in 10 of 186 (5.4%) *H. longicornis* ticks collected from domestic animals in the areas where the patients lived (Yu et al., 2011).

SFTSV infects a wide range of animals. In two SFTS-endemic counties of Shandong Province antibodies to the virus were detected in 328 (69.5%) of 472 sheep, 509 (60.5%) of 842 cattle, 136 (37.9%) of 359 dogs, 26 (3.1%) of 839 pigs, and 250 (47.4%) of 527 chickens. Zhao et al. (2012) reported that 2/237 (0.8%) healthy persons in Yiyuan County, Shandong Province, were seropositive for SFTS and concluded that subclinical SFTSV infections or a relatively mild form of SFTS illness may occur in humans. Phylogenetic analysis of the virus isolates obtained from the sheep, cattle, and dogs in this study and from *H. longicornis* ticks showed >95% homology with SFTS virus isolates obtained from patients from the same region, which suggests a potential link of SFTSV infections among humans, domesticated animals, and ticks (Niu et al.,

2013). SFTS deaths in China have been reported as recently as April-July 2020 (Anonymous, 2020).

In China during 2011–2012, 2,047 cases of SFTS were reported (46.65% male and 53.35% female(, with 129 deaths (55.04% male and 44.96% female) (Ding et al., 2013). The majority (74.89%) of SFTS cases during 2011–2012 in China occurred between May and August. Age of patients ranged from 1 year to 90 years (median, 58 years); most were farmers (81.40%), including agricultural and forest workers from rural areas. SFTS cases had a clustered distribution over 206 counties of eastern and central China; the provinces with highest number reported cases were Henan (48.22%), Hubei (21.89%), and Shandong (15.68%) (Ding et al., 2013). Mortality was significantly higher in non-farmers compared to farmers (10.13% vs 5.80%, $\chi 2 = 6.64$, $P < .01$). The median number of days between onset of illness to death was 9 days, and most fatalities (75.97%) occurred within 2 weeks of illness onset. Nationwide, the mortality, at a county level (<20 cases not included), ranged from 0.00% to 23.81% with the highest mortality in Penglai County, Shandong Province. Significantly, the mortality rate of the migrant population in the same province was higher than that of local residents (11.03% vs 6.26%, $\chi 2 = 6.93$, $P < .01$) (Ding et al., 2013).

Distribution

SFTS cases have been mainly reported in rural areas of the Eastern, Central, and North-Eastern China, where *Ha. longicornis* and *Rhipicephalus microplus* ticks are prevalent. The number of SFTS cases is relatively lower in urban areas than in rural areas. Using the average evolutionary rate, it was thought that SFTSV may have appeared 20–87 years ago in the Dabie Mountains, China and it was predicted that SFTSV might spread to some other regions of China, Japan, and South Korea. In China, based on the national surveillance data in 2011, 571 laboratory-confirmed cases were reported from 13 provinces, including 59 fatal cases. However, there may be more potential cases at the early stage of discovery. A number of SFTS cases have also been reported from Republic of Korea, Japan, Vietnam, and Taiwan.

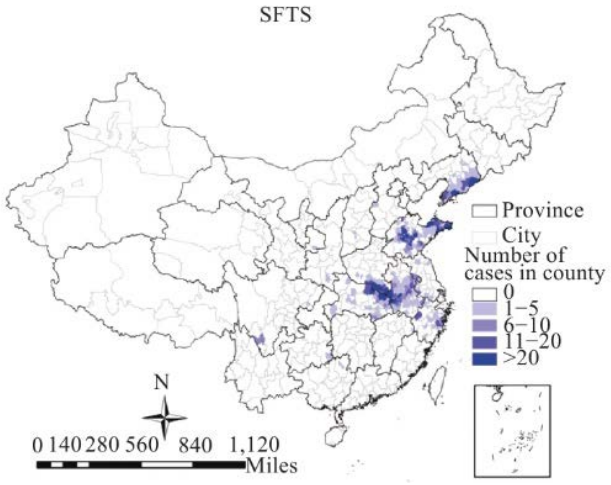


Figure 7. Spatial distribution of SFTS in Mainland China, 2018 (Liu and Gao, 2020).

Vector Ecology

SFTSV has been detected in *Haemaphysalis longicornis* ticks collected from domestic animals in the areas where SFTS patients lived (Yu et al., 2011), and fatal cases of SFTS have been

found to follow tick bites (Kang, 2013). However, conclusive evidence of tick transmission has yet to be demonstrated. The disease has been shown to be transmitted from person to person through contact with infected blood or mucous (Liu et al., 2012). The Asian longhorned tick, *Haemaphysalis longicornis*: *H. longicornis* is widely distributed in China, and is generally considered to be the arthropod vector of SFTS (Ding et al., 2013). Wang et al. (2015) examined a total of 3,145 ticks of four species, *Haemaphysalis longicornis* (3,048; 96.9%), *Rhipicephalus microplus* (82; 2.6%), *H. campanulata* (9; 0.3%), and *Dermacentor sinicus* (5; 0.2%) collected from animals and vegetation at Yantai in Shandong Province, China. SFTSV viral RNA was identified in *H. longicornis* and *R. microplus*, with a prevalence of 4.75 per 100 for ticks collected from animals and 2.24 per 100 for ticks collected from vegetation. The possibility that SFTSV transmission may occur by both the transstadial and transovarial routes was suggested by the fact that viral RNA was detected in *H. longicornis* at all developmental stages. This study implicates ticks as reservoirs of SFTSV as well as vectors (Wang et al., 2015).

Vector Surveillance and Suppression

Military personnel should use personal protective measures to prevent tick bites. Frequent self-examination and removal of ticks are important. See the Vector Surveillance and Suppression section in the Lyme Disease entry.

Tick-borne Encephalitis (TBE)

Background

TBE, caused by a complex of flaviviruses, actually comprises two clinically different diseases, Far Eastern TBE, also known as Russian spring-summer encephalitis (RSSE), and Central European TBE, also known as biphasic meningoencephalitis, or diphasic milk disease. Recent nucleotide and amino acid sequence analyses of European and Asian strains suggest that a third or Siberian subtype exists. Human disease of the Far Eastern subtype is usually clinically 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 7 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 persons over 40.

Distribution

TBE, primarily of the Far Eastern type, is focally distributed throughout China in ecological conditions that are favorable to the primary vector, *Ixodes persulcatus*, and small rodent reservoirs of the virus. During the 1990s, natural foci of TBE were reported in the Hunchun area of Jilin, China, where antibodies against TBE virus were detected in 12% of the sera from wild mice and 11% of the human sera that were tested. Foci of RSSE were also found in 4 counties of the Tianshan Mountains, Xinjiang. *Ixodes persulcatus* was collected in 18 counties of the Tianshan Mountains, as well as the Alatau, Taerbahati and Altai Mountains. In 1989, 2 strains of RSSE virus were isolated from *I. ovatus* ticks collected at 2700 m in the subtropical region of western Yunnan, China, near the Burmese border.

Vector Ecology

TBE is transmitted by multiple species of hard ticks, particularly *I. ricinus* or *I. persulcatus*. Vectors are widely distributed in brushy and broad-leaved (especially oak) mixed forest areas in rural and periurban areas. Several species of small mammals (especially yellow-necked field mice, bank voles, and hedgehogs) serve as reservoirs. Goats, cows, sheep, deer, and swine may become infected, but do not directly transmit virus to humans. However, unpasteurized milk products from infected animals may be a source of TBE outbreaks. *Ixodes persulcatus* is generally distributed across the northern half of China from east to west, including Mongolia and Manchuria. It also occurs widely in rural areas of Korea and Japan, especially in the northern sections of these countries. It is a three-host tick. Larval and nymphal ticks parasitize small forest mammals (rodents and shrews) and birds, especially thrushes and warblers. In warm, dry periods, the larval ticks remain under ground litter where they contact burrowing animals. On cooler summer days, they move above ground where they find larger animals. Nymphal stages quest for their hosts several inches above the forest floor, often waiting on low-lying vegetation. Adults quest from 20 to 60 cm above the forest floor and usually feed on larger wild and domestic animals, such as rabbits, deer, bear, carnivores, dogs, goats and humans.

Vector Surveillance and Suppression

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.

Other Vector-borne Diseases

Leishmaniasis

Background

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. Incubation in humans may take as little as 10 days or more than 6 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).

Distribution

Anthroponotic (human-to-human) transmission of CL due to *Le. tropica* occurs in urban centers and rural highland villages of western China. The disease is widespread in areas with a temperate climate (eastern and southeastern China), as well as those with an arid, cold climate (northcentral China including Inner Mongolia). Zoonotic (rodent to human) CL transmission due to *Le. major* occurs in western China to southwestern Mongolia in small villages or rural areas where four species of *Phlebotomus* maintain wild rodent leishmaniasis in gerbil and mouse populations. *Phlebotomus alexandrei*, *P. andrejievi, P. causicus* and *P. mongolensis* are the rodent-feeding sand flies that are suspected human vectors. Zoonotic CL is focally endemic and has been described as one of the major public health problems in southern Mongolia, where the reservoir is the great gerbil, *Rhombomys opimus*, and *Meriones spp.*

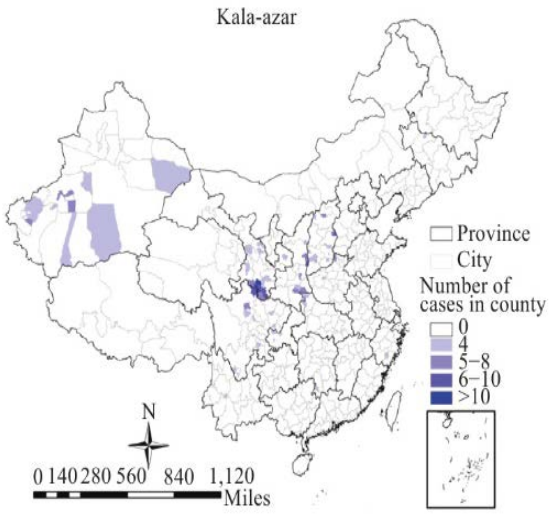


Figure 10. Spatial distribution of Kala-azal (Visceral Leishmanisas) in Mainland China, 2018 (Liu and Gao, 2020).

VL due to *Le. infantum* occurs from western China across the country to eastern China and the suburbs of Beijing. *Leishmania donovani* is transmitted by four species of sand flies (*P. alexandrei, P. chinensis, P. caucasicus* and *P. mongolensis*) in western China and southern Mongolia. VL is highly endemic in parts of China, where transmission is year-round, though risk is elevated during the peak of sand fly activity from April through October.

Vector Ecology

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 parts of homes and animal shelters. Abandoned structures and their vegetative overgrowth often become attractive wild or domestic rodent habitats and foci of rural CL.

Female sand flies are quiet “stealth biters,” and their bites may go unnoticed by military personnel. On humans, sand flies 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 has not been applied. Persons newly exposed to the bites of sand flies often experience a severe urticarial reaction until they become desensitized. Sand flies feed outdoors or indoors and readily penetrate the mesh of ordinary household screening or bednets. Bednets with a mesh size small enough to prevent passage of sand flies may restrict air flow and be uncomfortable for sleep in tropical climates. 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 allow for suitable hiding places and daytime resting sites are important habitats. Exact information on reservoirs and vectors requires more extensive study in East Asia. Vast areas of countries in this region remain unsurveyed for sand fly vectors and disease. When surveillance is conducted, sand fly vectors are often found in areas where they were previously unknown.

Disease Prevention and Control

Sand flies can penetrate standard mesh screening used on houses and standard mesh bed nets (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) bed nets can be used to exclude sand flies, 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.

Plague

Background

Plague is a zoonotic bacterial disease involving rodents and their fleas, some species of which occasionally transmit the infection to man and other animals. The infectious agent, *Yersinia pestis*, causes fever, chills, myalgia, nausea, sore throat and headache. Bacteria accumulate and swelling develops in the lymph nodes closest to the infected bite. Since most fleabites occur on the lower extremities, the nodes in the inguinal (groin) region are involved in 90% of cases. The term bubonic plague is derived from the swollen and tender buboes that develop. Plague is most easily treated with antibiotics in the early stages of the disease. However, untreated bubonic plague has a fatality rate of 50%. Infection may progress to septicemic plague, with dissemination of the bacteria in the bloodstream to diverse parts of the body. Secondary involvement of the lungs results in pneumonia. Pneumonic plague is of special medical significance since respiratory aerosols may serve as a source of person-to-person transmission. This can result in devastating epidemics in densely populated areas. Pneumonic and septicemic plague are invariably fatal when untreated but respond to early antibiotic therapy. Outbreaks of human plague are rare and typically occur in crowded urban settings associated with large increases in infected commensal rats (*Rattus rattus*) and their flea populations. Cases can occur year-round. Some untreated cases of bubonic plague may develop into secondary pneumonic plague. Respiratory transmission of pneumonic plague is rare but has the potential to cause significant outbreaks. Close contact is usually required for transmission. In situations where respiratory transmission of plague is suspected, weaponized agent must be considered.

Distribution

Foci of enzootic plague have been reported primarily from Gansu, Qinghai, and Yunnan Provinces, and from Nei Mongol, Xinjiang, and Xizang Autonomous Regions. Plague foci are primarily located in remote, rural mountainous or upland areas, and epizootics usually occur from March through May. Between 1959 and 1988, 23 outbreaks of plague involving 63 human cases were reported from Gansu Province. Most cases were acquired by hunting and handling infected marmots.

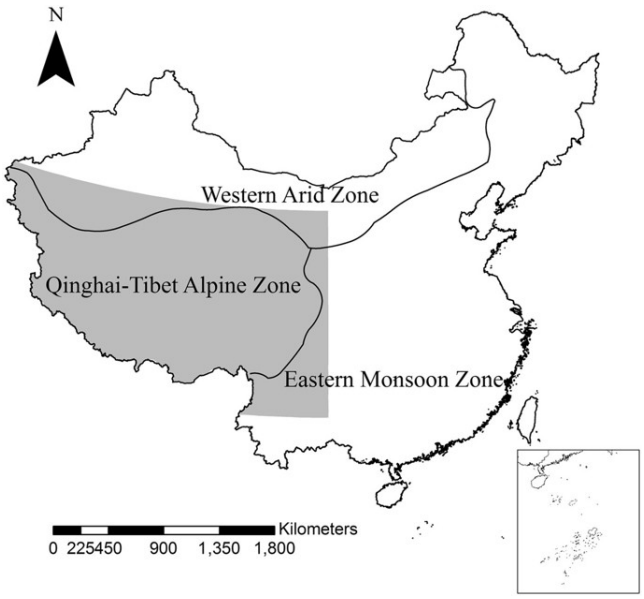


Figure 9. Areas of known plague foci in China (Qian et al., 2014).

Vector Ecology

Multiple flea species transmit plague; the oriental rat flea (*Xenopsylla cheopis*) is the most efficient vector for transmission of plague to humans. *Xenopsylla cheopis* occurs mostly in urban areas, in association with its rodent hosts. However, it may occur sporadically in villages when rats are present. Adult fleas feed exclusively on blood and utilize blood protein for egg production. 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

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.

Control of enzootic plague over large areas is not feasible. 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 in wild rodent habitats. 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 may incorporate an insecticidal dust that treats rodents while feeding or a rodent bait containing a systemic

insecticide that fleas ingest when taking a bloodmeal. However, baiting with systemic formulations may pose environmental risks. Military personnel should use personal protective measures to prevent flea bites.

Murine Typhus (flea-borne)

Background

The infectious agent, *Rickettsia typhi*, causes a debilitating illness with high fever and a maculo-papular rash. The incubation period ranges from 1 to 2 weeks, and clinical symptoms may last up to 2 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. It is not a notifiable disease in most countries.

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. Foci occur countrywide wherever rats are common, and transmission is year-round in tropical and subtropical regions. Murine typhus usually occurs in the summer and fall, while epidemic typhus generally occurs during colder months. Only sporadic cases have been reported in East Asian medical literature.

Vector Ecology

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*. *Rickettsia typhi* has also been isolated from *R. tanezumi* (*R. flavipectus*) in Yunnan Province. 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 the disease. Scratching fleabites increases the likelihood of infection, but *R. 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 in northern parts of East Asia.

The primary vector is the Oriental rat flea, *X. cheopis*. Potential secondary vectors for humans are the cat and dog fleas, *Ctenocephalides felis* and *C. canis*, as well as the human body louse*, Pediculus humanus humanus*. 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. *Rickettsia typhi* has been isolated from the rat fleas *Monopsyllus anisus* and *Leptopsylla segnis* collected from *R. flavipectus* in Yunnan Province. These rodent ectoparasites may also play a role in the enzootic cycle of murine typhus in China.

Vector Surveillance and Suppression

See Plague section for information about vector surveillance and suppression.

Scrub Typhus

Background

Scrub typhus is a rickettsial disease characterized by a primary skin ulcer (eschar) that occurs at the site of attachment by an infected mite. The infectious agent is *Orientia tsutsugamushi*. The incubation period is usually 10 to 14 days. Clinically, scrub typhus resembles other rickettsial diseases, with abrupt onset of fever, headache, malaise, and swollen lymph glands. Late in the first week of fever, a maculopapular rash appears on the trunk and extends to the extremities. Without antibiotic therapy, fever lasts about 2 weeks. The case fatality rate in untreated cases varies from 6% to 35% but in some instances can be as high as 60%, depending on the area, strain of rickettsia, and previous exposure to the disease. *Orientia tsutsugamushi* strains exhibit great antigenic and genetic variation. Following an attack of scrub typhus, immunity to the homologous strain persists for at least 1 year. Mortality is highest among the elderly.

Distribution

Enzootic foci are known from Fujian, Guangdong, Guizhou, Hainan, Heilongjiang, Hunan, Jiangsu, Jilin, Liaoning, Shandong, Sichuan, Tianjin, and Zhejiang Provinces, and the Guangxi and Xizang Autonomous Regions. The highest risk exists in the temperate provinces of southeastern China. Transmission occurs year-round in southern provinces and from June through August in northern provinces with temperate climates.

Vector Ecology

The disease is transmitted by the larval stage of mites (chiggers) in the family Trombiculidae. They are typically found in areas of grassy or scrubby vegetation, often in areas which have undergone clearing and regrowth. Habitats may include sandy beaches, mountain deserts, cultivated rice fields, and rain forests. Mites are the primary reservoir; the causative organism is maintained by transovarial transmission. The distribution of infected mites can be highly focal. Infected foci, known as "mite islands" or "typhus islands," can persist for years. Mites are frequently associated with rat populations, which sustain the vector but appear to have only a minor role as a reservoir.

Chigger vectors inhabit submontane, tropical, and temperate zones in East Asia. Hilly areas with disturbed vegetation are the primary habitats, and in many areas the life cycle continues year-round. Adult mites lay 1 to 5 eggs per day in damp, well-drained soil. Over a period of 6 to 12 weeks, 300 to 400 eggs may be deposited. The six-legged larvae that emerge ascend the tips of grasses to heights of 6 to 8 cm to await a suitable host. Most often, hosts are rodents, birds or insectivores, although humans are readily attacked. On people, the trunk and extremities are the primary attachment sites. Chiggers seek out areas where clothing is tight against the skin, such as the waist or ankles. A lesion or eschar usually develops at the feeding site of each infected chigger.

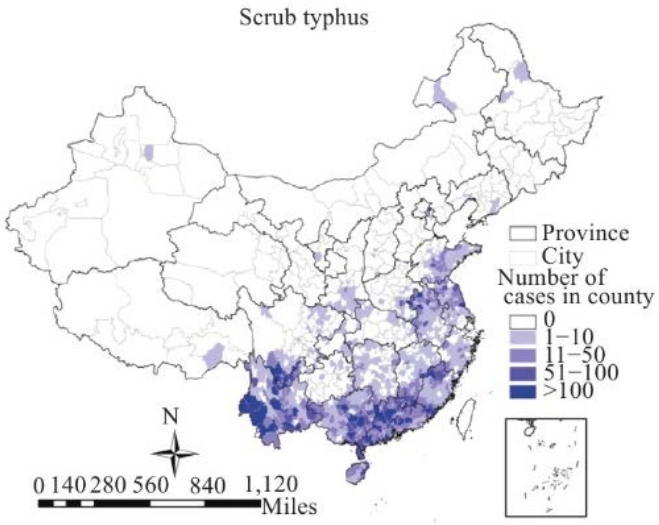


Figure 8. Spatial distribution of Scrub Typhus in Mainland China, 2018 (Liu and Gao, 2020).

Vector Surveillance and Suppression

Larval chiggers can be collected directly from hosts. Attached chiggers can be removed from dead or anesthetized animals with fine forceps and placed for temporary storage in 70% alcohol. Alternatively, a dead host can be placed in a jar with water and detergent, and the jar shaken vigorously to remove ectoparasites from the animal. The liquid is then poured into a funnel containing filter paper. Any mites will be strained out by the filter paper. Live hosts can be placed in cages that have wire or hardware cloth bottoms so that any mites that drop off after engorging will fall into a pan of water placed under the cage. In the field, 12-inch squares of black paper or plastic can be placed on the ground in suspected chigger habitat for 1 to 5 minutes, after which the total number of chigger mites that congregate on the black squares is counted. Locate plates about 100 m apart. Mites can be separated from nesting material, grass, leaves and other debris with a Berlese funnel. The wide and patchy distribution of chigger mites make their control very difficult. Vegetation can be removed mechanically or with herbicides around military encampments to make the habitat unsuitable for survival of the mites. Mite populations have been reduced by the application of residual insecticides, but this is generally not feasible over large areas. Limited applications of insecticides may be applied to the ground, vegetation, and environs of camps, buildings and paths traveled by people. Treated uniforms are highly effective against crawling arthropods like chiggers. If uniforms are not authorized, civilian clothing equivalently treated should be worn to provide the same protection.

Zoonotic Diseases

Hemorrhagic Fever with Renal Syndrome (HFRS)

Background

HFRS is caused by hantaviruses, 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. Disease 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. In Asia, severe illness is associated with Hantaan virus (HTN), and mild to moderate disease is associated with Seoul virus (SEO), primarily in Asia

Distribution

HTN virus claims 50,000 to 100,000 victims annually in China. HFRS is focally distributed countrywide but occurs primarily in hilly areas under 500 m and east of 100° E longitude from Yunnan Province in the south to Heilongjiang Province in the northeast. The disease is absent in mountainous and plateau regions above 2,000 m. In 1997, only Qinghai Province and Xinjiang Autonomous Region did not report cases. There is a nearly equal incidence of HTN and SEO viruses. HTN virus infection is occupationally associated with farming, camping, and military exercises. Risk of transmission is greater under dry, dusty conditions and when there are large populations of the striped field mouse, *Apodemus agrarius*. SEO virus infection is associated with large populations of *Rattus norvegicus* in urban settings. Transmission can occur year-round, but the incidence of HFRS caused by HTN virus in rural areas of Zhejiang Province exhibits a major peak in November and a minor peak in June. Both epidemic seasons coincide with peaks of the *A. agrarius* population and local agricultural activities. SEO virus infections occur primarily during the months of December through May as a result of exposure to domestic rodents in the home. Similar patterns of transmission have been observed in other areas of China.

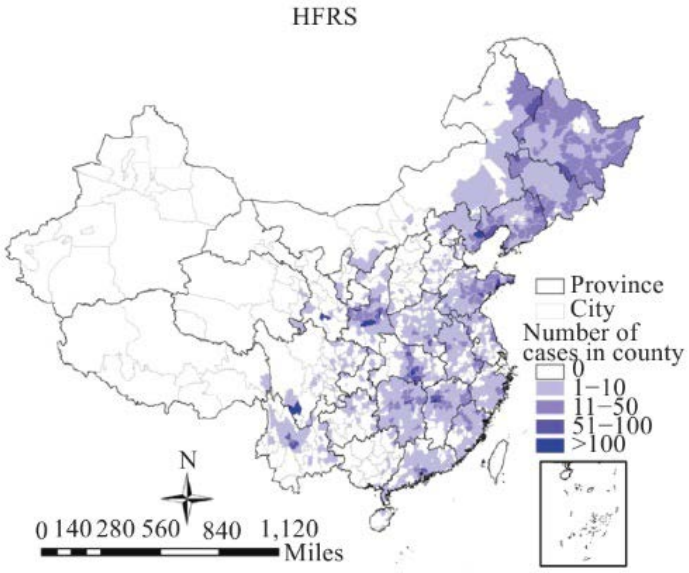


Figure 11. Spatial distribution of HFRS in Mainland China, 2018 (Liu and Gao, 2020).

Vector Ecology

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.

Each hantavirus appears to have a single predominant murid reservoir. HTN is commonly associated with the field mouse*, A. agrarius*, in open field or unforested habitats. The red bank vole, *C. glareolus*, inhabits woodland or forest-steppe environments and is a primary reservoir for PUU. DOB has been isolated from the yellow-necked field mouse, *A. flavicollis*, in open fields and unforested foothills. The domestic rat, *R. norvegicus*, is the reservoir for SEO worldwide. The common European vole, *Microtus arvalis*, appears to be the primary reservoir 147 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 which subsequently dock at ports worldwide. A serological survey of rodents in Taiwan found a much higher hantaviral antibody prevalence in international seaports than in domestic seaports. 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 and shelters infested by infected rodents.

Disease Prevention and Control

To prevent hantaviral disease, exclude or prevent rodent access to buildings. Food should be stored 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 feed or tame wild rodents. Rodents frequently urinate or bite when handled.

Leptospirosis

Background

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 at least 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 largely determined by the infecting strain and health of the individual. In some areas of enzootic leptospirosis, most infections are mild or asymptomatic.

Distribution

Outbreaks have occurred, especially in several southern provinces. Leptospirosis is endemic in 26 of China’s 30 provinces. Distribution of endemic areas is primarily located between 25° to 35° N latitude and between 100° and 120° E longitude, particularly in those provinces with drainage areas along the Yangtze and Huaihe rivers.

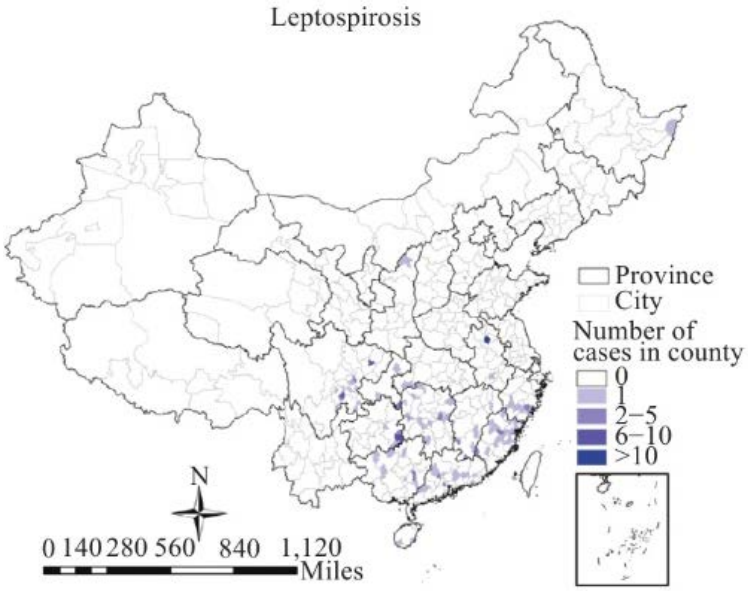


Figure 12. Spatial distribution of Leptospirosis in Mainland China, 2018 (Liu and Gao, 2020).

Disease Ecology

Leptospira bacteria infect the kidneys and are transmitted in the urine of infected animals. Humans become infected through contact of abraded 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 uncommon. Spirochetes disappear from whole milk within a few hours. 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

Disease Prevention and Control

To prevent leptospirosis, domestic rodents need to be controlled 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 or adopting stray dogs or cats as pets. Leptospirosis could be a problem following flooding of contaminated streams or rivers.

Q Fever

Background

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. Infection 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.

Distribution

The risk from direct or indirect animal contact is likely to be highest in rural areas where livestock are present. However, the risk from contaminated milk products exists countrywide, including in urban areas.

Vector Ecology

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 *Haemaphysalis campanulat*a in Sichuan and from *Hyalomma asiaticum* in Xinjiang. The role of these ticks in the epidemiology of Q fever in East Asia is unknown.

Vector Surveillance and Suppression

Measures to identify and decontaminate infected areas and to vaccinate domestic animals are difficult, expensive and impractical. *Coxiella burnetii* is resistant to many disinfectants. Military personnel should avoid consumption of local dairy products and contact with domestic animals, hides or carcasses. Soldiers should not rest, sleep, or work in or near animal sheds or other areas where livestock have been housed.

Rabies

Background

Rabies is a significant health problem in China. The Ministry of Health (MOH) reports more than 2,400 people killed each year from rabies. In China, most infections are caused by dog bites, with an annual average of 40 million people on the mainland reporting animal bites. It is estimated that China has 75 million dogs, but less than 20 percent are vaccinated against rabies.

Distribution

Rabies is distributed countrywide across China. Dogs are the main source of all human exposures (more than 96 percent), and domestic cats are the second most common source (2 percent). Other reservoir species reported include bats, foxes, leopards, and wolves. Occasional cases are reported in badgers, bears, camels, cattle, deer, donkeys, hedgehogs, horses, jackals, and pigs. See Wang et al., 2014, for additional information.

Disease Prevention and Control

All contact with local animals, especially dogs and cats should be strictly avoided. Personnel embedded with local populations should receive rabies vaccination prior to deployment.

Schistosomiasis

Background

This disease is caused by trematodes in the genus *Schistosoma* that live in the veins of humans and other vertebrates. Eggs from adult worms produce minute granulomata (nodular lesions) and scars in the organs where they lodge. Symptoms are related to the number and location of

the eggs. The most severe pathological effects are the complications that result from chronic infection.

Humans are the principal reservoir for schistosomes; humans shed schistosome eggs in urine or feces. Animals such as cattle and water buffalo may also be significant reservoirs. Lakes, streams, or irrigated fields frequently are contaminated with human and animal waste containing schistosome eggs. When water temperatures are at or above 20 degrees Celsius (68 degrees Fahrenheit), the eggs hatch, releasing larvae. If a suitable freshwater snail species is present, the larvae penetrate the snail and, after a period of development, emerge as free-swimming cercariae. Cercariae infect human hosts by penetrating skin, usually while the person is wading or swimming. Exceptionally heavy concentrations of schistosomes may occur in discrete foci, which are difficult to distinguish from less contaminated areas. In nonimmune personnel exposed to such foci, rates of acute schistosomiasis can be very high (over 50 percent).

Distribution

Risk areas include the central and lower Yangtze River Valley, including its tributaries and adjacent lakes. In addition, schistosomiasis is widespread in areas south of 35 degrees north latitude, including Hunan, Jiangxi, Yunnan, and Zhejiang Provinces in southern China, and usually occurs in marshlands or riverbanks and canals overgrown with vegetation in those areas. Anhui, Hubei, Hunan, Jiangsu, and Jiangxi Provinces in central and southern China account for approximately 86 percent of all cases in the country. Guangxi Autonomous Region was declared schistosomiasis free as of 1989.

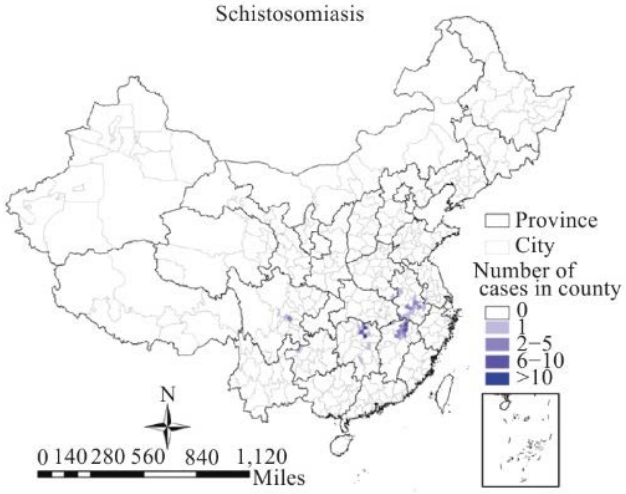


Figure 13. Spatial distribution of Schistosomiasis in Mainland China, 2018 (Liu and Gao, 2020).

Vector Ecology

The freshwater snails *Oncomelania hupensis hupensis, O. nosophora*, and *O*. *quadrasi* occur in the middle lakes region along the Yangtze River Basin. Only *O. h. hupensis* (Fig. 14) has been incriminated as a vector of human schistosomes in China. Infection rates in snails frequently range from 14 to 26%. *Oncomelania hupensis hupensis* favors rice field irrigation ditches, fishponds, or small streams with emergent vegetation. These snails occur only in areas that are flooded 3 to 8 months a year. The snails in the Yangtze River Basin are large and coarsely ribbed. The *Oncomelania* subspecies in Yunnan and Sichuan Provinces differ from those in the

middle lakes region and tend to occur in or around villages in the extensive hilly areas of these provinces, where irrigation channels or stream banks are favored habitats. These snails are small and finely ribbed. In the hill region, rabbits are an important zoonotic host. Snails and schistosomes occur less often in the low coastal plains of Zhejiang and Jiangsu Provinces. The snails in this area are medium-sized and moderately ribbed. They tend to live along the margins of slow-moving streams or channels. *Oncomelania* snails are amphibious and conical in shape. These snails possess gills, and the shell's aperture can be closed by means of an operculum. The death rate increases significantly after snails have been submerged for over 60 days. *Oncomelania* snails can infect passersby that contact infected snails clinging to grass or bamboo stalks. Male snails are generally smaller than females, and infection rates are generally higher in females, which shed cercariae over a longer period (33 weeks for females versus about 18 weeks for males).

Figure 14. *Oncomelania hupensis hupensis* (Image credit: Qin Ping Zhao (Department of Parasitology, School of Basic Medical Science, Wuhan University, Wuhan, Hubei Province, China) - PLoS Neglected Tropical Diseases March 2010 Image page, CC BY 2.5, https://commons.wikimedia.org/w/index.php?curid=9936412)

Disease Prevention and Control

The most important preventive measure in reducing the incidence of schistosomiasis is avoidance of fresh water with infective cercariae. Military personnel should assume that all fresh water in endemic areas is infested unless proven otherwise. The absence of snails in an area does not preclude infection, since cercariae can be transported considerable distances by water currents. Commanders and troops must be instructed in the risk of infection and measures for schistosomiasis prevention. No topical repellent is currently available that provides long-term protection against cercarial penetration. Cercariae are killed by exposure for 30 minutes to concentrations of chlorine of 1 ppm. Treating water with iodine tablets is also effective. Heating water to 50°C for 5 minutes or allowing it to stand for 72 hours will render it free of infective cercariae. Water purification filters and reverse osmosis units are also effective in removing cercariae.

Soil-transmitted Helminths (hookworm, strongyloidiasis, cutaneous larva migrans)

Background

Soil-transmitted helminths (STH) are intestinal worms, including *Ascaris* roundworms, whipworms, hookworms, and *Strongyloides* roundworms, that infect humans through contaminated soil. STHs are widely distributed throughout the developing world in areas where sanitation is poor, particularly in tropical areas.

When animal-shed hookworm larvae penetrate human skin, they leave a reddened, inflamed subcutaneous track as they burrow, giving rise to the name cutaneous larva migrans. Hookworms that infect animals typically cannot complete their life cycle in humans and remain in the skin without causing systemic symptoms.

Distribution

Risk is year-round in southern China. Risk is seasonal in central and northern China, typically running from April to December in central China and from July to November in northern China.

Worm larvae require relatively warm and moist soil for survival. Highest risk environments include locations subject to indiscriminate human defecation ("defecation fields"), fields fertilized with human waste ("night soil"), areas around poorly constructed local latrines, or areas with sewage-contaminated run-off.

Vector Ecology

Ascaris roundworms (*Ascaris lumbricoides*) and whipworms (*Trichuris trichiura*): People become infected by the human parasites *Ascaris* roundworms and whipworms when infective parasite eggs are ingested by eating with soil-contaminated hands/nails or consuming soil-contaminated food, such as undercooked or unwashed fruits/vegetables. Most infections are mild and often do not cause symptoms in humans.

Human hookworm species, *Ancylostoma duodenale* and *Necator americanus*, are also transmitted through soil contaminated by human feces containing worm eggs that hatch into larvae (immature worms) in optimal environments. Larvae penetrate skin, usually when walking barefoot on contaminated soil. Cutaneous larva migrans (CLM) is a reaction in humans caused by hookworm larvae that normally infect animals, such as cats, dogs, and wildlife, resulting in inflammation, severe itching, and raised red lines near the site of penetration (usually the foot). Rarely, certain animal hookworm species can infect humans, causing symptoms of infection as the worms complete their lifecycle.

Strongyloides stercoralis is a human parasite transmitted through contact with soil contaminated with infective larvae, which penetrate bare skin. In humans, worm eggs hatch into larvae in the intestines; the larvae then pass in feces into the environment. Some larvae may immediately re-infect the intestines or the skin of the anal area as they pass (auto-infection), which likely contributes to life-long infection (often without symptoms and undiagnosed for decades), unless properly treated. Initial infection may produce an itchy rash at the site of skin penetration. A recurring urticarial (red, bumpy, itchy) rash due to repeated autoinfection often hallmarks chronic infection by larvae primarily around the buttocks, anus, and thighs, which may be differentiated from CLM due to its rapid advancement, of over 2 inches(5 cm)/hour.

Disease Prevention and Control

Avoid contact with potentially infected soil and water. Prevention and control should include availability to potable water for personal and domestic uses, improved sanitation including clean

and functioning toilet use by all community members, and education and proper hygiene and safe food preparation.

Arthropods of Military Significance

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 can be 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 real 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 China:

Acari (ticks and mites)

Scabies is the most important disease caused by mite infestation, and infestations have been common during military conflict.

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 mange in other animals, including primates, horses, wild and domestic ruminants, pigs, camels, rabbits, dogs and other carnivores.

Scabies mites principally burrow 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. 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 burrows parallel to the skin surface. Burrowing may proceed up to 5 mm per day, and the burrow may extend over a cm in length. Mites feed on liquids oozing from dermal cells that have been chewed. Females lay 1 to 3 eggs per day in their tunnels and rarely leave their burrows. Eggs hatch into six-legged larvae that crawl out of the burrows onto the surface of the skin. Larvae burrow into the skin or a hair follicle and form a pocket in which they molt into the nymphal stage. Nymphs molt into adults, and the male

burrows into the molting pocket in the skin and mates with the female. The female begins to burrow through the skin only after fertilization. Adult males can be found in short burrows or pockets in the skin or wandering around on the skin surface. The life cycle from egg to adult takes about 10 to 14 days. Adult females live about a month on humans but survive only a few days off the host. Clothing or bedding kept unused for about 5 days is usually free of mites.

Scabies is transmitted from person to person by close, prolonged personal contact. Transmission is common in dormitories, barracks and medical facilities. It is possible to get infested by sleeping in a bed formerly occupied by an infested person, but experimental work has indicated this rarely happens. Exposure for ten minutes at 50°C will kill mites. In newly infested persons, a period of 3 to 4 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 causing pustules, eczema and impetigo. In infested persons, an extensive rash can cover areas where there are no mites, and a rash may persist for several weeks after all scabies mites have been killed. 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 or crusted scabies. With a highly contagious condition like scabies it is important to treat all persons living in close association with an infested individual.

Feeding by chiggers can cause an intense itchy dermatitis leading to pustules and sometimes to secondary infection. Most temperate zone chiggers have one annual generation.

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 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 4 to 6 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.

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. Tickbite 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. *Ixodes nipponensis* is one of the most common species of ticks responsible for tick bites in South Korea. The bite frequently results in panniculitis with firm nodules 1 to 4 cm in diameter forming in the subcutaneous fatty tissue of the skin. 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. Red meat allergy, an allergic reaction to mammalian meat containing α-Gal oligosaccharide is triggered by bites from ticks in the genus *Amblyomma* in the United States, *Ixodes* in Australia and Europe, and *Haemaphysalis* in Japan, so may occur in China.

Araneae (spiders)

More than 35,000 species of spiders have been described worldwide. All spiders, except for 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 species 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 East Asia the widow spiders, *Latrodectus* spp. (family Theridiidae), and the sac spiders, *Chiracanthium* spp. (family Clubionidae), are responsible for significant local and systemic effects from envenomization.

The black widow, *L*. *mactans*, is widespread throughout the region. This species is also referred to as the hourglass, shoe button, or po-ko-moo spider. It is more common in warm climates and is more likely to be found in human habitations than other widow spiders in the region. 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 do not 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. Antivenoms are commercially available and very effective.

Sac spiders of the genus *Chiracanthium* have a cytolytic venom that produces cutaneous necrosis in 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. The consequences of bites include severe local pain, fever, swelling and redness, with a small area of necrosis at the site of the bite.

Scorpionida (scorpions)

These arthropods have a stout cephalothorax, 4 pairs of legs, a pair of large anterior pedipalps with enlarged claws, and a tail tipped with a bulbous poison gland and stinger. Some species carry the tail above the dorsum of the thorax, while others drag it behind. All species of scorpions are venomous. However, of over 1,400 described species worldwide, fewer than 25, all in the family Buthidae, possess a venom that is life threatening to humans. Most produce a reaction in humans comparable to a bee sting. 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.

Scorpions use their sting to capture prey, for defense against predators, and during mating. The venom sacs are controlled voluntarily, so a scorpion can regulate how much venom is injected with each sting. Some scorpions may not inject any venom while stinging. Scorpion venom is a

complex mixture of substances that may include several neurotoxins, histamine, seratonin, enzymes, and other unidentified components. The venom of most species has never been analyzed. Some scorpion venoms are among the most toxic substances known; fortunately, only a small amount is injected, probably less than 0.5 mg. There is evidence indicating that the toxicity of any species' venom is highly variable across its geographic range. Thus, a species that is dangerous in one area may not be hazardous in another.

There are numerous scorpions in China. Scorpions of the *Mesobuthus eupeus* species complex exist in China and Mongolia, and their venom is considered quite toxic. An antivenom is produced for it. The scorpion *Mesobuthus martensii* injects a mildly toxic venom that increases the heart rate and raises the blood pressure. *Mesobuthus martensii* envenomation is a common medical problem in China. This species is widely collected and cultured for use as a medicine in many countries of East Asia. *Isometrus maculatus* and *Liocheles australiasiae* have become widespread in the region, and *L. australiasiae* is common on Okinawa. Stings of *I. maculatus* are painful and cause local skin lesions. A list of scorpions reported from China appears in Table 3.

Table 3: Scorpion Species in China
Buthidae
Isometrus maculatus
Lychas mucronatus
L. scutilis
Mesobuthus eupeus
M. eupeus mongolicus
M. eupeus thersites
M. martensii
Olivierus caucasicus
O. caucasicus intermedius
O. caucasicus przewalskii
Ischnuridae
Liocheles australasiae
Scorpiosidae
Scorpiops hardwickei
S. hardwickei hardwickei
S. hardwickei jendeki
S. tibetanus

Most scorpion stings are to the lower extremities or the arms and hands. Among indigenous populations, stings are more often inflicted at night, while scorpions are actively hunting for prey. Scorpion stings can occur year-round in tropical areas of East Asia. However, in areas with temperate climates, most stings are reported during the warmer months of March to October.

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 initial sharp pain, numbness, and localized swelling dissipating in 1 to 3 hours with no systemic findings; 2) those who, in addition to pain, have 1 or 2 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. The clinical management of scorpion envenomation is controversial. Those with type 1, 2, or 3 manifestations can be managed by applying ice to slow the spread of the venom 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. Only in rare cases do symptoms extend beyond 72 hours. 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.

Solifugae (sun spiders, wind scorpions)

These arthropods inhabit tropical and subtropical desert environments in Africa, Asia, Europe, and the Americas. One species, *Gylippus rickmersi*, has been reported from the Pamir plateau in Central Asia at an elevation of over 3,000 m. They usually avoid oases and other fertile places, seeming to prefer utterly neglected regions where the soil is broken and bare. Their hairy, spider-like appearance and ability to run rapidly across the ground account for their common names. Sun spiders range from 20 to 35 mm in body length and are usually pale colored. They have very large, powerful chelicerae, giving them a ferocious appearance. They can inflict a painful bite but do not have venom glands. Sun spiders are largely nocturnal, hiding during the day under objects or in burrows. They are aggressive and voracious predators on other arthropods. They easily kill scorpions and may even capture small lizards. At night they sometimes enter tents to catch flies or other insects.

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 1 to 5 hours. Several species of this genus known to bite man occur in East Asia. *Scolopendra subspinipes mutilans*, *S. subspinipes multidens* and *S. mojiangica* are widespread tropical species that are most often incriminated in human bites. Specimens up to 30 cm in length have been collected in Taiwan. *Scolopendra* bites produce excruciating local pain, erythema and swelling. Centipedes bite using their first pair of trunk appendages (maxillipeds), which have evolved into large, claw-like structures. Two puncture wounds at the site of attack characterize a centipede bite, and they are sometimes confused with the bite marks of a viper. 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 used in many parts of East Asia in traditional medicine to treat arthritis and other ailments.

Centipedes are flattened in appearance and have 1 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.

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.

Five nymphal instars precede the adult stage. Each nymph must take a bloodmeal in order to molt. Adults live up to 1 year. Bed bugs take about 5 minutes to obtain a full bloodmeal. They can survive long periods of time without feeding, reappearing from their hiding places when hosts become available. Females may live several months and lay 50 to 200 eggs over their lifetime. 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. Eggs and cast nymphal skins may be observed in cracks and crevices.

Infestations of bed bugs in human habitations are not uncommon in many areas of East Asia. Bed bugs can be introduced into barracks through infested baggage, bedding and belongings. They may pass from the clothing of one person to another on crowded public vehicles. In the absence of humans, bed bugs will feed on rats, mice, bats or birds. Therefore, old dwellings should be surveyed for these and other pests before they are occupied during contingency situations. *Cimex lectularius* and *C. hemipterus* commonly feed on poultry in many parts of the region, so poultry houses should be avoided by military personnel.

Dipterans Causing Myiasis

Myiasis refers to the condition of fly maggots infesting the organs and tissues of people or animals. Worldwide there are 3 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*, *Chrysomyia*, *Calliphora* and *Lucilia*, have been recorded as causing cutaneous myiasis. Flies in the genus *Lucilia* are known as greenbottle flies due to their metallic or coppery green color.

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 common in East Asia. Several cases occurred in U.S. 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.

The Old World screw-worm fly, *Chrysomyia bezziana* (family Calliphoridae), is a common myiasis-producing fly from Southeast Asia to China. Adult *C*. *bezziana* only oviposit on live mammals, depositing 150 to 500 eggs at wound sites or in body orifices (ears, nose, mouth and urogenital openings). The larvae hatch in 18 to 24 hours, molt once after 12 to 18 hours, and a second time about 30 hours later. They feed for 3 to 4 days and drop to the ground to pupate. The pupal stage lasts 7 to 9 days under tropical conditions. *Chrysomya megacephala* is common in some parts of East Asia and is often called the Oriental latrine fly because of its habit of breeding in feces as well as on carrion and other decomposing organic matter. It can occur in large numbers around latrines and become a nuisance in open-air meat and fish markets. The larvae can cause a secondary myiasis of wounds in man and animals.

Myiasis is rarely fatal, but troops living in the field during combat are at 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.

Several other species of flies commonly cause myiasis in cattle (e.g., *Hypoderma* spp.) and in horses and donkeys (e.g., *Gasterophilus* spp.), and their larvae sometimes infest humans. 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.

Simuliidae (black flies, buffalo gnats, turkey gnats)

Black flies are small (3 to 5 mm), usually dark, stout-bodied, hump-backed flies with short wings. Despite their appearance, black flies are strong flyers, and some species are capable of dispersing up to 30 km from their breeding sites. Only females suck blood, although both sexes feed on plant juices and nectars. They can emerge in large numbers and be serious pests of both livestock and humans. A characteristic of many species is the mass emergence of thousands of adults during a short period. Black flies bite during the day and in the open. Some species have a bimodal pattern of activity, with peaks around 0900 hrs in the morning and 1700 hrs in the afternoon, but in shaded areas biting is more evenly distributed throughout the day.

Some species feed exclusively on birds and others on mammalian hosts. The arms, legs, face, and nape of the neck are common sites of attack, especially at the edge of exposed skin. Black fly bites are painful and 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 East Asia and are a significant source of human discomfort. Black fly larvae usually require clean, flowing water but may be common in or near urban areas.

Ceratopogonidae (biting midges, no-see-ums, punkies)

The Ceratopogonidae is a large family containing nearly 5,000 species in over 60 genera. These extremely small flies (1 to 2 mm) 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). Only females suck blood. In East Asia, 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. Many species of *Culicoides* are zoophilic. *Leptoconops* are more likely to be a major nuisance to man. However, *Forcipomyia taiwana* is one of the most annoying blood-sucking pests in Taiwan. It is distributed island-wide in urban and suburban habitats, including scenic sites and public parks. Populations of this species have dramatically increased as a result of agricultural practices on the island. *Forcipomyia taiwana* attacks exposed parts of the body during the day, causing intense pruritis and swelling in sensitive individuals. Blood-sucking species predominately feed and rest outdoors, entering houses in much smaller numbers. *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 and 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. Most species remain within 500 m of their breeding grounds, although some species of *Culicoides* and *Leptoconops* are known to fly 2 to 3 km without the assistance of wind. Ceratopogonidae are troublesome mainly under calm conditions, and the number of flies declines rapidly with increasing wind speed.

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. Some important species breed in sandy areas near the seashore, where they can be a serious economic threat to the tourist industry. There are 4 larval instars, and a fully grown larva is only about 5 to 6 mm long. In warm climates larval development is completed within 14 to 25 days. Many species exploit specialized habitats such as tree holes, decaying vegetation, and cattle dung. In militarily secure areas, encampments should be 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 in extensive or diffuse habitats. Adult control typically includes applying residual insecticides to fly harborages, treating screens and bednets with pyrethroids, and using repellents. Ultra low

volume application of aerosols may produce temporary control, but sprayed areas are soon invaded by midges from unsprayed areas. Ceratopogonids have difficulty biting through clothing because of their short mouthparts, so even an untreated uniform can provide considerable protection.

Tabanidae (deer flies and horse 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. Larval development is prolonged, and many species spend 1 to 2 years as larvae. In temperate regions the entire life cycle can take 2 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. Carnivorous tabanid larvae occasionally bite humans, such as military personnel walking barefoot in rice fields or other areas containing such larvae. These bites can be quite painful.

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). *Chrysops* and *Tabanus* have a worldwide distribution. *Haematopota* species, also known as clegs or stouts, are not found in South America or Australia, and only a few species occur in North America. However, they are common in Europe, Asia, Africa, India and East Asia.

Only female tabanids bite and take a bloodmeal, 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. They locate their hosts mainly by sight (color and movement), although olfactory stimuli like carbon dioxide and other host odors are involved. Because of their preference for dark objects, they tend to bite through colored clothing rather than light- colored skin. Their large mouthparts enable them to penetrate many types of clothing.

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, and these flies have been incriminated in the transmission of tularemia. Because their bites are painful, tabanids are frequently disturbed while feeding and move readily from host to host. In East Asia 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 due to the difficulty in locating breeding places. Since larvae of most species live below the surface of the soil, insecticides would not penetrate the soil and vegetation and contact the immature stages. Similar problems are encountered in the control of ceratopogonid larvae. 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 of limited effectiveness against these flies.

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 3 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 East Asia. Wild strains of honey bees may be more aggressive than domesticated populations maintained by beekeepers.

Ants can bite, sting and squirt the contents of the poison gland through the tip of the 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. The Samsum ant, *Pachycondyla sennaarensis*, has been responsible for many hypersensitive reactions in South Korea. 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 2 categories, immediate (within 2 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. The toxicity of African honey bee venom is roughly equivalent to the toxicity of the venom of domesticated honey bees. Large local reactions are characterized by painful swellings 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.

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 several 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.

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 eye, where they can cause nodular conjunctivitis. Urticating hairs can also become attached to the cocoon when the larva pupates, 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.

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 a large variation in individual susceptibility to blistering from cantharidin. Blisters are generally not serious and normally clear within 7 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. Insects containing cantharidin are commonly used throughout East Asia in traditional folk medicine for their irritant properties. Military personnel should be warned about the medical risks of using local folk medicines.

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 (<5 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, which 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 readily enter houses or other buildings at night. They 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. *Paederus fuscipes* is commonly implicated in outbreaks of dermatitis in East Asia. It is abundant in rice fields, where larvae and adults are predaceous on other arthropods.

Siphonaptera (fleas)

Flea bites can be an immense source of discomfort. The typical flea bite 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 flea bites. In sensitized individuals, a delayed papular reaction with intense itching may require medical treatment.

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 East Asia are the cosmopolitan cat and dog fleas, *Ctenocephalides felis* and *C*. *canis*, the Oriental rat flea, *Xenopsylla cheopis*, and the human flea, *Pulex irritans*. Occasionally, fleas parasitizing birds nesting in human dwellings may bite humans in the absence of their hosts.

Personal Protective Measures

For additional information, refer to Armed Forces Pest Management Board Technical Guide No. 36, Personal Protective Measures against Insects and other Arthropods of Military Significance

The concurrent use of repellents on the skin (DEET/Picaridin/IR3535) and clothing (permethrin) provides maximum personal protection against arthropods. This dual strategy is known as the DoD Insect Repellent System and is explained in more depth in Figure 14.

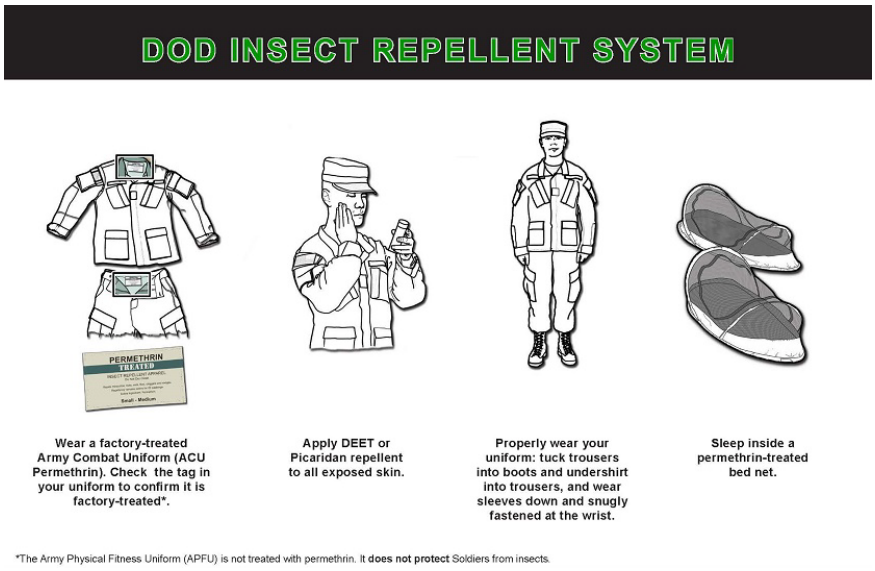


Figure 14. DoD Insect Repellent System

The approach to protection against arthropod bites is influenced by the level of protection that is needed in a specific situation. For example, a combination of chemically treated gear and clothing and a strong chemical repellent may be necessary in areas with high concentrations of disease-carrying arthropods. In contrast, milder repellents may be sufficient for preventing nuisance bites in areas with low levels of disease vectors. The phylum Arthropoda includes both insects and arachnids, although the terms "arthropod" and "insect" are used interchangeably in this topic review.

Repellents are variably useful in deterring mosquitoes, biting flies, fleas, midges, chiggers, and ticks.

Repellents are not effective against stinging insects, such as Hymenoptera species (yellow jackets, wasps, bees, hornets, imported fire ants, and harvester ants) or against spiders. Unlike bloodsucking arthropods, stinging insects and spiders do not seek out humans to feed. Rather, they sting/bite humans reflexively in self-defense or to defend the nest (some Hymenoptera) or egg sacs (some spiders), and it is not possible to chemically deter these extreme behaviors short of using an insecticide.

Among repellents for which a mechanism of action has been described, some act as agonists at olfactory receptors, binding the receptors and blocking recognition of suitable prey. Others antagonize olfactory receptors and actively reverse a normally attractive scent into a deterring scent. Due to highly divergent receptors, the same compound may act as an agonist in one species and an antagonist in another.

The EPA provides an online search tool to help choose a repellent product, accessible at:

https://www.epa.gov/insect-repellents/find-repellent-right-you#search%20tool

Application

Guidelines regarding the safe and effective use of insect repellents in order to maximize effectiveness and minimize side effects have been issued by the United States Environmental Protection Agency (EPA). These are particularly important when using DEET-based repellents:

- Use just enough repellent to lightly cover but not saturate the skin.
- Repellents should be applied to exposed skin, clothing, or both but not under clothing.
- A thin layer can be applied to the face by dispensing repellent into the palms, rubbing hands together, and then applying to the face.
- Repellent should be washed from the palms after application to prevent contact with the eyes, mouth, and genitals.
- Do not use repellents over cuts and wounds or inflamed, irritated, or eczematous skin.
- Do not inhale aerosols, spray them in enclosed spaces or near food, or get them into the eyes.
- Do not apply insect repellent to the hands of small children, as it will inevitably be rubbed into the eyes.
- Frequent reapplication of repellent is unnecessary.
- The areas treated with repellent should be washed with soap and water once the repellent is no longer needed.
- If both sunscreen and repellent are being applied, sunscreen should be applied first, and repellent should be applied after. It is better to use separate sunscreen and repellent products, as sunscreen generally needs to be reapplied more frequently than repellent.

Protection is shortened by swimming, washing, sweating, wiping, exercise, and rainfall.

Specific Active Ingredients

The most effective insect repellents are:

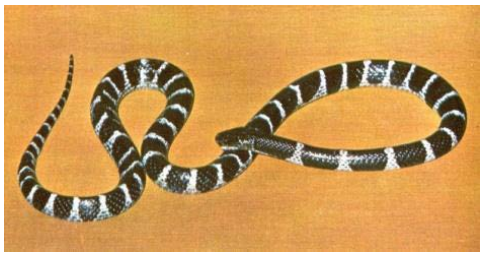
- DEET (N,N-diethyl-3-methylbenzamide)
- Picaridin (KBR 3023)
- PMD (P-menthane-3,8-diol)
- BioUD (2-undecanone)
- IR3535
- Metofluthrin (spatial)
- Transfluthrin (spatial)

These agents are not all equal in efficacy and provide varying degrees of protection against different arthropods.

Venomous Animals

Many-banded Krait *(Bungarus multicinctus)*

Risk Severity: High



Description: Medium to large-sized, smooth scaled, body with a distinct vertebral ridge, one pair of upper fixed front fangs, adults usually 80 -100 cm long (max. 180 cm); body black or bluish-black, with 21-30 white or creamy white cross bands (7-11 whitish bands on pointed tail), 15 longitudinal dorsal rows of scales at mid-body. Belly white or dirty-white.

Habitat: Commonly found in open woodland, grassy fields, and bamboo groves adjacent to water, such as ditches, rice paddies and streams. May be found in villages and suburban areas. Fairly geographically widespread. Found up to 1,300 m elevation, in southern China, Burma, Indonesia, and most of Southeast Asia. Activity and Behavior: Not well known. Terrestrial, strongly nocturnal, sluggish by day, more active at night. Venomous.

Characteristics: Extremely potent neurotoxin. Local symptoms minimal. Bite usually felt as a pinprick followed by slight itching, numbness, or redness; local swelling minimal. Systemic symptoms may include nausea, vomiting, drooping of the upper or lower eyelid (ptosis), inability to speak, swallow, or open mouth, chest tightness, and breathing difficulties. Human fatalities due to bites by this spp. have been reported. Antivenom is available: http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN0023

Russell's Viper *(Daboia russelii)*

Risk Severity: High

Description: Terrestrial, medium-to-large, stout viper, adults usually 100-150 cm long (max. 160+ cm); body orange, pink or gray, with 3 longitudinal rows of large, dark-edged spots, often interspersed by 2 additional rows of smaller but similar markings, 27-33 mid-body dorsal scale rows, belly yellowish-white, often with dark brown markings, scales strongly keeled, head triangular and distinct from body.

Habitat: Found mainly in fairly open dry woodlands and grassy hills, sometimes in the margins of fields or paths, up to 2,000 m elevation. Found from Pakistan eastward through southern China and southward through Indonesia.

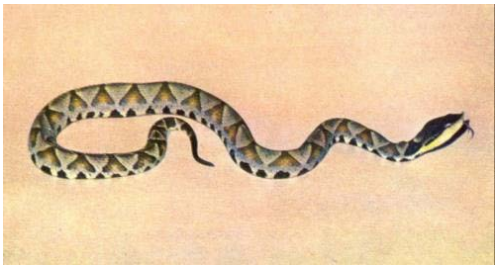
Activity and Behavior: Mainly terrestrial, nocturnal; when threatened, produces a very loud drawn-out hissing.

Venom Characteristics: Responsible for >1/2 of all reported venomous snake bites in southern Asia. Potent mainly hemotoxic venom, known to cause numerous serious human fatalities each year. Antivenom is available: http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN0055

Chinese Moccasin *(Deinagkistrodon acutus)*

Risk Severity: High

Description: Medium-sized, fairly stout-bodied pit viper, adults usually 0.8-1.0 m long (max. 1.5 m). Usually light brown or grayish-brown with a series of dark brown triangles along each side. Pointed tops of 2 opposite triangles join mid-dorsally, creating an effect of alternating triangles of different colors. Head dark brown with beige or pinkish sides, with upturned, pointed snout and dark brown postorbital stripe running back from each eye to the side of the head. Hatchlings lighter with vivid patterns.



Habitat: Found mainly on forested low mountain slopes or rock hills with small valleys, but also found in forested mountains up to 1,400 m elevation and low coastal areas at 100 m elevation. During day, may be seen on rocks or in vegetation along streams. Found in eastern, central and southern China, southern Taiwan, northern Vietnam and Laos.

Activity and Behavior: Mainly terrestrial and most active at night or in evening but sometimes basks in the sun on exposed rocks or logs. Appears sluggish in fields but strikes and bites vigorously when aroused. Remains coiled ready to strike at any time. Especially during fall season, hunts for rodents in or near paddies, in gardens, along roadsides, or in houses.

Venom Characteristics: Potent hemotoxin; strongly hemorrhagic. Envenomation symptoms include severe local pain and bleeding, which may begin almost immediately, followed by serious swelling, blistering, necrosis, and ulceration. Systemic symptoms may occur early and often include heart palpitations. Human fatalities have been reported. Antivenom is available:

http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN0081

Tibetan Pit Viper / Strauch's Pit Viper *(Gloydius strauchi)*

Risk Severity: Intermediate

Description: Very similar in body size, stoutness, colors and patterns to both *G. intermedius* and *G. saxatilis*; paler overall, and more generally gray, with less obvious markings. Species diagnostic differences in scalation may require close examination to determine.

Habitat: Found mainly in open woodlands and rocky hillsides with grass and scrub brush on high hillsides, mainly in central and southern China (esp. Tibet).

Activity and Behavior: Not much known. Probably mainly diurnal, mainly terrestrial, ovoviviparous (clutch size not reported, but probably <20); prey mainly on available small mammals and birds.

Venom Characteristics: Not much known. Probably mainly hemotoxic. Potentially lethal envenoming of human. Generalized symptoms caused by envenomation of humans by a related species. Antivenom is not available.

Yellow Sea Snake *(Hydrophis spiralis)*

Risk Severity: High

Description: Large sea snake, adults usually 170-180 cm long (max. 270 cm); body golden yellow, yellow-green, or olive, with black crossbands that may encircle body, head yellow, juveniles have black heads with yellow mark on top. Tail distinctly oar-like.

Habitat: Found mainly in deep to moderately deep, yet relatively near-shore, coastal marine waters.

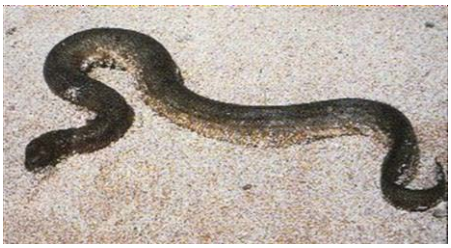
Activity and Behavior: Both diurnal and nocturnal, preys mainly on eels and other elongate fish along bottom of sandy or silted seabed or shallow reefs, commonly inhabits bottom zones at depths below 10 m.

Venom Characteristics: Contains very potent neurotoxins and myotoxins. Larger than most sea snakes and has relatively longer fangs and greater supply of venom. Untreated envenomation likely to be fatal. This species causes many human deaths every year (mainly fishermen or divers). Antivenom is available: http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN0580

Stokes Sea Snake (*Hydrophis stokesii)*

Risk Severity: High

Description: Largest of the sea snakes, reaching a maximum length of about 1.8 m. Very heavy-bodied, with colors varying from black through shades of grey to dull white. Indistinct pattern of blotches, reticulations or crossbands may be present. Has a raised ventral keel formed by its elongated and divided ventral scales



Habitat: Found only in marine waters (usually found at >10 m deep).

Activity and Behavior: Usually found in deep, open marine water, especially where there is turbidity or silting.

Venom Characteristics: Mainly neurotoxic. Antivenom is available: http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN0552

Indian Spectacled Cobra *(Naja naja)*

Risk Severity: High

Description: Large, heavy-bodied cobra, adults usually 1.5-2.0 m long (max. 2.4 m). Body usually dark-brown or black to yellowish-white above and white or yellowish below. Distinctive markings include spectacle mark on top (dorsal surface) of expanded hood, with dark spot in middle of lighter ring, or within each "lens" of the "spectacles".

Habitat: Found in a variety of habitats: flat grasslands and jungles, among scattered trees, near rice fields and other cultivated areas, and near settlements. It is found at sea level and higher elevations (to at least 300 m).

Activity and Behavior: Mainly diurnal; most active in evening and early morning. This species is not usually aggressive, but when threatened or cornered it lifts the upper body and spreads a hood. It often lives in holes in embankments, hollows of trees.

Venom Characteristics: Potent neurotoxin with some hemotoxic factors. May cause severe local pain and swelling immediately after bite; dark discoloration, necrosis, and blistering may occur within 72 hours. Systemic symptoms include headache, nausea, vomiting, and drooping eyelids. Thousands of bites of humans and many deaths occur. Antivenom is available: http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN0041

Jerdon's Pit Viper, Red Spotted Pit Viper *(Protobothrops jerdonii)*

Risk Severity: Intermediate

Description: Large pit viper with adults reaching 1.0-1.2 m long (max. about 1.4 m). The body is lime to olive-green, with every scale edged in black. The underside is black with scattered yellowish-to-orange spots and speckling (spots bigger and more numerous laterally).

Habitat: Mainly found in montane forests and scrubland, in southern and southeastern Asia, up to 2,800 m elevation.

Activity and Behavior: Not very well known. Semi-arboreal and crepuscular (or nocturnal), mainly feeds on small mammals and birds.

Venom Characteristics: Little is known, but likely hemotoxic, with procoagulins and possibly cytotoxic factors. No serious human envenomation or deaths reported. Antivenom is available: http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN0102

Brown Spotted Pit Viper *(Protobothrops mucrosquamatus)*

Risk Severity: High

Description: Rather long, thin pit viper, adults usually 0.8-1.0 m long (max. 1.3 m). Body light-brown or grayish-brown; vertebral row of large purplish-brown or chocolate-colored spots sometimes edged with a yellow line. Lateral row of small dark blotches on each side. Head brown above, white below, belly white but heavily powdered with brown, 25 midbody dorsal scale rows

Habitat: Mainly found in open agricultural country and forests up to 1,400 m elevation. Also found in bamboo forests, shrubs, stream banks, tea fields, and round human dwellings. Limited mainly to southern and southeastern Asia.

Activity and Behavior: Terrestrial, mainly nocturnal but sometimes active in daytime. Usually slow-moving but can strike quickly if disturbed.

Venom Characteristics: Potent hemotoxin. Usually causes severe local pain and swelling. Systemic symptoms may include nausea, vomiting, epigastric pain, fever, and shock. Human deaths from envenomation occur reach year. Antivenom is available: http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN0111

Orange-collared Keelback *(Rhabdophis himalayanus)*

Risk Severity: High

Description: Small to medium-sized, slender water snake (usually only in fresh water), adults usually about 50-60 cm long. Body varies from pale to medium brown (often with orange tinge) above, with lighter gray-brown to yellowish-brown belly, and narrow distinct orange-red ring around its neck. Dorsal scales rough (keeled); ungrooved, fixed, and enlarged rear fangs.

Habitat: Mainly found in brushy or grassy areas alongside streams, ditches or paddies. Found from near sea level to above 400 m elevation. Limited to southern and southeastern Asia.

Activity and Behavior: Mainly nocturnal, semi-aquatic, spreads its neck ("hood-like") when threatened, usually seems reluctant to bite humans. Seldom encountered by humans. Eats mainly frogs, toads, and/or fish. Oviparous (usually <12 eggs/ clutch).

Venom Characteristics: Not much known. Mainly hemotoxic, possibly with neurotoxic factors. Related species (2) in this genus have caused human deaths, mainly due to acute renal failure. Antivenom is not available.

Hubei Keelback *(Rhabdophis nuchalis)*

Risk Severity: High

Description: Medium-sized, fairly slender, cylindrical freshwater snake, adults usually <80 cm long. Dorsal scales keeled, head dark gray to brown above, and with fixed rear fangs. Body color variable, usually gray-brown, medium brown or greenish-brown above (darker brown toward tail), some with small scattered darker speckling or blotches along flanks. Chin and throat usually white or light gray. Belly usually pale brownish to gray to dull white with irregular dark spots along sides (especially toward tail).

Habitat: This species is found mainly in grassy or brushy areas beside or near streams, ditches or paddies.

Activity and Behavior: Mainly nocturnal, semi-aquatic; reluctant to bite humans, but may spread its neck and threaten if provoked or restrained.

Venom Characteristics: Not well known. Mainly hemotoxic, possibly with some neurotoxic factors. Envenomation by closely related species have caused human deaths due to renal failure. Antivenom is not available.

White-lipped Pit Viper *(Trimeresurus albolabris)*

Risk Severity: High

Description: Medium-sized, long, thin arboreal pit viper with triangular head, distinct from neck; adults usually 40-60 cm long (max. 100 cm). Body uniformly green, varies from yellowish-green to bright grass-green. May have darker crossbands. Belly greenish, yellow or white; 21 midbody dorsal scale rows. Head with a pair of heat-sensing pits between nostrils and eyes, and with a pair of hinged (folding) upper front fangs.

Habitat: Found mainly in open tropical forests or bamboo thickets, and cultivated land, at low elevations. Often found around human habitations and in gardens. Widespread in Southeast Asia.

Activity and Behavior: Mainly nocturnal and arboreal; rarely seen on ground except after dark. Usually slow moving, especially during the daytime, and not aggressive except when disturbed.

Venom Characteristics: Mainly hemotoxic. Symptoms may include local pain, swelling, bruising, and tender enlargement of local lymph nodes. Systemic symptoms may include nausea, vomiting, diarrhea, abdominal pain, lethargy, gastrointestinal bleeding, and presence of blood in the urine. Bites occur frequently, but few human deaths have been reported. Antivenom is available:
http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN0088

Banded Krait (*Bungarus fasciatus*)

Risk Severity: High

Description: Medium to large-sized, terrestrial, smooth scaled, one pair of upper fixed front fangs, adults usually 100 -120 cm long (max. 210 cm); with a pattern of alternating light and dark bands circling body. Light bands pale to bright canary yellow; dark bands usually black, and wider; tail blunt. Distinctive light spear-shaped mark, bordered by black, on top of head; and with a distinct vertebral ridge most of body length.

Habitat: Most common in grassy fields, meadows, and cultivated areas, often adjacent to streams, rivers, and lakes. Found up to 1,500 m elevation in Burma (Myanmar), Brunei Darussalam, southern China, India, Indonesia and most of Southeast Asia.

Activity and Behavior: Normally terrestrial and mainly nocturnal; may prowl in the daytime during and after rains. Usually inoffensive and secretive. Hides head beneath body if provoked; may twitch or writhe spasmodically but seldom attempts to bite even when provoked.

Venom Characteristics: Potent neurotoxin. Minimal local pain, redness, or edema. Systemic symptoms develop slowly; include general achiness, paralysis, shock, and respiratory failure.

Bites of humans are rare, but fatalities have been reported. Antivenom is available: http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN0018

McClelland's Coral Snake *(Sinomicrurus macclellandi)*

Risk Severity: Intermediate

Description: Small, slender, cylindrical, adults 63-78 cm long (max. 80 cm), body usually dark reddish/ brownish (russet-pink) above, with 23-40 thin, widely spaced, black, light-edged bands (some incomplete on flanks). Head black with very broad ivory-colored band behind eyes, bordered behind by broad black band; chin cream, belly yellowish with black marks. Tail with 2-6 thin black bands. Body scales smooth, in 13 parallel longitudinal mid-body dorsal rows.

Habitat: Found mainly in forest litter, near streams of lowlands (up to 1,000 m) throughout most of Southeast Asia. Tend to avoid very dry and open places.

Activity and Behavior: Mainly nocturnal and terrestrial (semi-burrowing).

Venom Characteristics: Not well studied, but probably mainly neurotoxic (like most Elapids). Very few reported cases of human envenomation (at least once reported to have caused fatality of a child) and those are not well documented. Antivenom is available: http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN0033

Dwarf Sea Snake, Banded Sea Snake *(Hydrophis caerulescens)*

Risk Severity: Intermediate

Description: Small-to-medium sized sea snake, adults usually about 70 cm long (max. 80 cm); body bluish-gray with bluish-black or dark purple crossbands, belly whitish, head dark gray; juveniles sometimes have yellow markings on their head which fade with age.

Habitat: Usually found in near-shore shallow water, near bottom among rock crevices, coral boulders or pilings. Found from along the Pakistan coast east to Australia, southern China, and Southeast Asia.

Activity and Behavior: During regional rainy season, this species breeds in estuaries among rocks. Usually non-aggressive, even when handled. Both diurnal and nocturnal, stays in marine waters, probably feeds on various bottom-dwelling fish.

Venom Characteristics: Not much known. Probably have potent neurotoxins and myotoxins. Very few bites or envenomation of humans reported, and no human fatalities reported. Antivenom is available: http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN0565

Tonkin Pit Viper *(Ovophis tonkinensis)*

Risk Severity: Intermediate

Description: Small to medium-sized, stocky terrestrial pit viper with very short snout, adults usually <80 cm long. Body pale brown, reddish-brown, or olive-brown, darker brownish dorsal blotches often form a zigzag pattern along the dorsal mid-line, 19-21 midbody dorsal scale rows. Head with darker brownish central blotch on top, brown postorbital stripe.

Habitat: Found in mountains and plateaus from coastal lowlands to above 1,000 m. Usually found in shrubby, partly open vegetation, and sometimes in cultivated areas. Limited to southern China (including the island of Hainan) and Vietnam.

Activity and Behavior: Not well known, but mainly terrestrial, probably mainly nocturnal.

Venom Characteristics: Not much known, but probably hemotoxic. Human envenomation occurs, but deaths have not been reported. Antivenom is not available.

Speckle-bellied Keelback *(Rhabdophis callichroma)*

Risk Severity: Intermediate

Description: Medium-sized, slender, cylindrical, freshwater snake, adults usually 50-60 cm long (max. 77 cm), with dorsal scales keeled. Body greenish brown with small red spots along flanks (these fade toward tail), chin and belly white with black spots along sides. Head dark brown to black above, juveniles with white to yellow chevron (points toward tail) on top of their neck (this disappears with age).

Habitat: Found mainly in brushy or grassy sites in open montane forests, relatively near edges of streams, ditches, or rice paddies. Occur up to 1,700 m elevation. Limited to Vietnam, southern China, Philippines and Indonesia.

Activity and Behavior: Mainly diurnal (active during the day, especially soon after rain; or at dusk), semi-aquatic, not overly aggressive unless provoked or greatly restrained.

Venom Characteristics: Much is unknown, but likely hemotoxic with some neurotoxic factors. Antivenom is not available.

Green Keelback *(Rhabdophis nigrocinctus)*

Risk Severity: Intermediate

Description: Medium-sized, slender, cylindrical, freshwater snake, adults usually 65-80 cm long (max. 95 cm). Body usually dark green in front, becomes brownish toward tail, with slightly slanted (toward head, at their upper end) very thin vertical black bands along each side which sometimes meet at middorsal line. Dorsal scales rather rough (keeled), with 15-21 midbody rows. Head dark brown with variable pattern of black lines and fixed rear fangs. Chin, throat, and belly white (grayish toward tail).

Habitat: Mainly found in brush-covered or grassy fields adjacent to streams, ditches, or paddies. Occurs up to 2,100 m elevation. Limited to several southeastern Asian countries.

Activity and Behavior: Mainly nocturnal, semi-aquatic, reluctant to bite humans unless provoked.

Venom Characteristics: Not much known. Probably mainly hemotoxic (procoagulants), and possibly also with mild neurotoxic factors. No reported serious human envenomation or deaths reported. Antivenom is not available**.**

Common Bamboo Viper *(Trimeresurus gramineus)*

Risk Severity: Intermediate

Description: Medium-sized, slender arboreal pit viper, adults usually 60-80 cm long (max. 110 cm). Body usually uniformly green (sometimes bronze-green), with irregular pattern of black, or bronze-green flecks. Belly pale white, yellow, or pale green. Narrow, longitudinal whitish, yellowish, or bluish lateral line alongside. Head with a pair of lateral frontal heat-sensing pits and a pair of folding, upper front fangs. Tail usually mainly reddish-brown.

Habitat: Mainly found in bamboo thickets, vine tangles, and dense foliage adjacent to streams or other water sources; usually from near sea level to about 400 m elevation. Often comes up around human habitations and agricultural areas.

Activity and Behavior: Mainly nocturnal, arboreal, and slow-moving (at least by day). Usually remains quiet when approached, but often strikes quickly if touched or otherwise threatened.

Venom Characteristics: Primarily hemotoxic. Envenomation symptoms usually include local pain and swelling, nausea, vomiting, and fever reported. Human deaths "rarely, if ever" occur. Antivenom is available:
http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN2629

Motuo Bamboo Pit Viper (*Trimersurus medoensis)*

Risk Severity: Intermediate

Description: Medium-sized slender pit viper, adults usually 65-67 cm long (max. about 75 cm) with 17 midbody dorsal rows of keeled scales. Usually green or bluish-green above with yellowish-white belly, 2-colored (red below, white above) ventrolateral stripe along both sides of the body in both sexes. Has a pair of movable, upper, front fangs and a loreal (the region between the eyes and nostrils) heat-detecting pit between the eye and nostril on each side of its head. Prehensile tail usually dull reddish-brown.

Habitat: Found mainly in margins and along paths in seasonally wet sub-tropical forests of southern and southeastern Asia. Typically found in stands of bamboo and associated plants, often found near streams, at moderate elevations (up to 1200+ m).

Activity and Behavior: Mainly arboreal and nocturnal, but not well studied. Probably ovoviviparous (litter size not reported, so far). Probably preys on available lizards, small mammals, birds, and frogs (juveniles probably eat arthropods, too).

Venom Characteristics: Not well studied, but likely mainly hemotoxic. Reports of human envenomation by this species are not well documented and may have been confused because this is one of 3 new species recently split from *V. stejnegeri* (formerly called *Trimeresurus stejnege*ri). No specific antivenom is currently being produced against this species. Bivalent and polyvalent antivenoms are available—see http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.display&id=SN0110.

Chinese Bamboo Pit Viper *(Trimeresurus stejnegeri)*

Risk Severity: Intermediate

Description: Medium-sized, fairly stout, arboreal pit viper; adults usually 60-70 cm long (max. 100 cm). Body uniformly leaf-green to chartreuse-green; no markings except thin white, yellowish-white, or red-and-white (red below, white above) stripe along each side, usually 21 midbody dorsal rows of keeled scales. Belly pale green, prehensile tail terracotta or rust-colored above.

Habitat: Mainly found in montane forest areas, usually in bamboo thickets, bushes, and trees along water courses; found more frequently on hillsides than on level terrain, often in edges of agricultural areas. Most common in Cambodia, southern China, isolated sites in Myanmar and Thailand, and Vietnam; occurs rarely in certain other southern Asian and southeastern Asian countries.

Activity and Behavior: Mainly arboreal (maybe semi-arboreal) and mainly nocturnal. Sluggish by day. Usually calm disposition but strikes quickly if surprised or brushed against while resting in arboreal shelters. When threatened while on the ground, may coil and rapidly vibrate tail as a warning.

Venom Characteristics: Mainly hemotoxic. Envenomation symptoms include severe local pain, oozing from fang marks, extensive local swelling, bruising, nausea, and vomiting. Many bites of

humans in agricultural areas, or people who walk along narrow bamboo forest trails. Human fatalities recorded but not common. Antivenom is available: http://www.toxinology.com/fusebox.cfm?fuseaction=main.snakes.displayandid=SN0116

Lionfish, Firefish, Zebrafish *(Pterois volitans)*

Risk Severity: High

Description: Adults can be >43 cm long and weigh >1,1 kg, with distinctive red, maroon, and white stripes; fleshy tentacles above eyes and below mouth; fan-like pectoral fins, and long separated dorsal spines. Well-developed venom glands associated with dorsal, pectoral and anal (fin) spines.

Habitat: Found only in marine waters, mainly around coral reefs at 100+ feet depth. Found along suitable reefs throughout most of the Pacific and Indian Oceans.

Activity and Behavior: Usually slow-swimming predatory fish, feeding on various available marine organisms (mainly smaller fish), often rest in crevices or swim slowly along near surface of coral reef. If approached, will often turn to point dorsal spines toward intruder. Not usually aggressive, but if provoked, will actively try to "stick" intruder with dorsal, pectoral or anal spines.

Venom Characteristics: Mainly neurotoxic and cytotoxic with strong cardiotoxic and possibly myotoxic factors. Envenomation (sting) usually causes intense local and radiating pain at wound site. Hypotension, vasodilatation, cardiac rhythm changes, respiratory difficulty, primary shock, cardiac or respiratory arrest, and death can occur. Antivenom is not available.

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 East Asia are listed in Table 2.

Members of the *Rhus* group (poison ivy, oak, and sumac) are the most frequent causes of acute allergic contact dermatitis. About 70% of the U.S. 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 1 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 dermatitis in a sensitive person who touches the object. 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 are only partially effective. Allergy to poison ivy, oak and sumac may also mean a person is allergic to related plants, including cashews, pistachios, mangos and Chinese or Japanese lacquer trees (*Toxicodendron verniciflua*). A thick viscous sap derived from the bark of the Japanese lacquer tree is used for varnishing furniture and many other objects. Once applied, the lacquer may retain its allergenicity for many years. The ginkgo tree, *Ginkgo*

biloba, is native to western China but is widely planted along streets and in gardens. Its fruit contains compounds similar to urushiol that can cause a contact dermatitis resembling poison ivy dermatitis.

Table 2: Plant Species in China that Cause Contact Dermatitis.
Aconitum spp.
Actaea spp.
Aleurites spp.
Ammannia spp.
Argermone spp.
Campis spp.
Croton spp.
Daphne spp.
Datura spp.
Euphorbia spp.
Ginkgo biloba
Jatropha spp.
Laportea spp.
Mangifera spp.
Mucuna spp.
Rhus spp. (*Toxicodendron* spp.)
Ricinus communis
Sapium spp.
Semecarpus spp.
Sterculia spp.
Urtica spp.

Contact urticaria may result from immunological or non-immunological host responses, although the latter is more common. Nettles, such as *Urtica* spp. and *Laportea* spp., are examples of plants that cause non-immunological contact urticaria. These plants have hollow stinging hairs that release a chemical after penetration of the skin. A burning sensation occurs almost immediately. Urticaria from contact with the hairs of some plants can be severe, persisting for days or even weeks.

A number of cultivated plants of the carrot and rue families sensitize the skin to long-wave ultraviolet light (phytophotodermatitis). Within 6 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 eye. *Daphne* spp. and *Mucuna* spp. are examples of plant containing chemical irritants. The latex of some *Euphorbia* spp. is highly irritating and may cause blindness if it contacts the eyes.

Mechanical injury by splinters, thorns, spines and sharp leaf edges can produce visual impairment or fungal and bacterial infections at the site of injury. Plant thorns and spines may introduce infective microorganisms, including *Clostridium tetani*, into the skin and sub-cutaneous tissues. 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. Many bulbs and some plants, notably *Dieffenbachia*, the popular house plant known as dumb cane, contain calcium oxalate. This water-insoluble salt forms bundles of needle-like crystals that can cause severe irritation with they become embedded in the skin or mucosae. Plant juice containing calcium oxalate causes severe pain when splashed into the eyes, and large numbers of calcium oxalate crystals may penetrate the cornea.

Links to Additional Information

AFPMB Technical Guide 24, Contingency Pest Management Guide:

https://extranet.acq.osd.mil/eie/afpmb/cac/techguides/tg24.pdf

Other AFPMB Technical Guides, and Pesticide and Equipment lists:

https://www.acq.osd.mil/eie/afpmb/products.html

WRBU Insect keys and identification services:

http://www.wrbu.org/index.html

VectorMap – Vector and vector-borne distribution maps:

http://vectormap.si.edu/

IR Mapper – Insecticide resistance mapping worldwide:

http://www.irmapper.com/

Army Public Health Command Entomology and Pest Management – Technical assistance:

https://phc.amedd.army.mil/topics/envirohealth/epm/Pages/default.aspx

National Center for Medical Intelligence – Current information about diseases:

https://www.ncmi.dodiis.mil/

American Mosquito Control Association – Mosquito and mosquito-borne diseases:

http://www.mosquito.org/

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