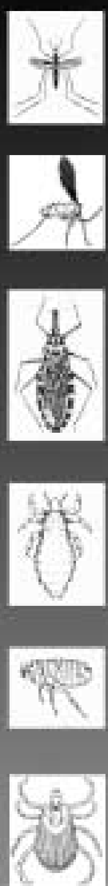
Disease Vector Ecology Profile

Peru

Office of the Deputy Under Secretary of Defense for Environmental Security



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PREFACE

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

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

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

Contingency Operations Assistance: The Armed Forces Pest Management Board (AFPMB) is staffed with a Contingency Liaison Officer (CLO), who can help identify appropriate DoD personnel, equipment, and supplies necessary for vector surveillance and control during contingencies. Contact the CLO at Tel: (301) 295-8300, DSN: 295-8300, or Fax: (301) 295-7473.

Defense Pest Management Information Analysis Center (DPMIAC) Services: In addition to DVEPs, the DPMIAC publishes Technical Information Bulletins (TIBs), Technical Information Memoranda (TIMs), and the Military Pest Management Handbook (MPMH). The DPMIAC can provide online literature searches of databases on pest management, medical entomology, pest identification, pesticide toxicology, and other biomedical topics. DPMIAC also operates a home page on the Internet, from which documents of current operational interest, such as TIMs, DVEPs, and recent editions of TIBs can be downloaded. Customers can also conduct their own literature abstract data searches online. The home page address is: **http://www. afpmb.org**/. Contact DPMIAC at Tel: (301) 295-7476, DSN: 295-7476, or Fax: (301) 295-7483. Additional hard copies or diskettes of this publication are also available.

Other Sources of Information: The epidemiologies of arthropod-borne diseases are constantly changing, especially in developing countries undergoing rapid growth, ecological change, and/or large migrations of refugee populations resulting from civil strife. Therefore, DVEPs should be supplemented with the most current information on public health and geographical medicine. Current disease risk assessments, additional information on parasitic and infectious diseases, and other aspects of medical intelligence can be obtained from the Armed Forces Medical

Intelligence Center (AFMIC), Fort Detrick, Frederick, MD 21701, Tel: (301) 663-7511, DSN: 343-7511. Disease Risk Assessment Profiles (DISRAPs) and Vector Risk Assessment Profiles (VECTRAPs) for most countries in the world can be obtained from the Navy Preventive Medicine Information System (NAPMIS) by contacting the Navy Environmental Health Center (NEHC) at Tel: (804) 444-7575 ext. 456, DSN: 564-4657 ext. 456. Information is also available from the Defense Environmental Network and Information Exchange (DENIX) home page address: **http://denix.cecer.army.mil/denix/denix.html**

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

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

For insect repellents, pesticides and respirators: Contact the Defense General Supply Center ESOC at Tel: (805) 275-4865, DSN: 695-4865. The ESOC is staffed seven days a week/24 hours a day.

For application equipment: Contact the Defense Construction Supply Center ESOC at Tel: (614) 238-2271/3191, DSN: 850-2271/3191.

For personal protection equipment (bednets, headnets, etc.): Contact the Defense Personnel Support Center at Tel: (215) 737-3042/3043, DSN: 444-3042/3043.

Every effort is made to ensure the accuracy of the information contained in DVEPs. Individuals having additional information, corrections, or suggestions, are encouraged to provide them to the Chief, DPMIAC, Armed Forces Pest Management Board, Forest Glen Section, Walter Reed Army Medical Center, Washington, DC 20307-5001; Tel: (301) 295-7476, DSN: 295-7476; Fax: (301) 295-7483.

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Appendices

I. Executive Summary

Slightly smaller than Alaska, Peru is divided into three topographic regions: 1) A narrow band of arid **coastline** ca. 50 km/30 mi wide that extends from the Pacific Ocean to the base of the Andes Mountains. In Lima, annual daily minimum and maximum temperatures average 16° and 24°C, respectively. 2) The three **Andean ranges** that parallel the coast. The wet season occurs from October through April with annual daily minimum and maximum temperatures that average 4° and 21°C, respectively, in Cuzco. 3) The vast **eastern region** (63% of the country's area) that stretches from the Andes to the tropical Amazon Basin. Significant flooding occurs in lowland areas during the rainy season (October through June), with annual daily minimum and maximum temperatures that average 16° and 30°C, respectively, in Iquitos.

Malaria, transmitted by the bite of infected *Anopheles* mosquitoes, occurs mainly below 1,500 m in the northwestern departments, particularly in Piura where infection rates greater than 25% occur along the Peru-Ecuador border. Some malaria occurs above 2,000 m in Ancash Department. In many areas, *Plasmodium vivax* is dominant (98+%), followed by *P. falciparum* (1+%, reportedly increasing), and *P. malariae* (0.5%, the predominant species in Junin Department). However, *P. falciparum* accounts for more than 50% of the cases in many areas of the Amazon Basin. Fansidar® and chloroquine resistance occur in the Amazon Basin of northeast Peru. The urban center of Lima is malaria free, but *P. vivax* occurs in the southeast and northern suburbs. The highland cities of Cuzco, Machupicchu and Lake Titicaca are malaria free. Preventive measures against malaria include sanitation improvements to eliminate mosquito breeding sites, application of residual insecticides to vector resting sites and aerosol insecticides to screened living and sleeping areas, use of permethrin-impregnated bednets for sleeping, prompt and effective treatment of cases, and conscientious use of chemoprophylaxis and personal protective measures (**PPM**). **PPM** are outlined in Appendix H.

Dengue fever can debilitate its victims as early as three days following the bite of an infected mosquito. The highest risk for dengue is in northern coastal and eastern lowland urban areas. In 1990, an outbreak of 150,000 cases occurred in the vicinity of Iquitos, Loreto Department, where dengue continues to be a problem. Outbreaks also occurred in Piura and Junin Departments in 1992. Individuals who have previously had dengue fever are at increased risk of developing the more serious dengue hemorrhagic fever/dengue shock syndrome. Use **PPM** against mosquitoes.

Venezuelan equine encephalitis (VEE), **eastern equine encephalitis** (EEE), and **St. Louis encephalitis** (SLE) are mosquito-borne diseases that are enzootic in the Amazon Basin, with some outbreaks occurring in coastal areas. **Mayaro virus** occurs east of the Andes in tropical foothills and in the Amazon Basin. Other mosquito-borne viruses include **Caraparu**, **Guama**, **Marituba**, **Oriboca** and **Ilheus**. **Oropouche virus**, transmitted by biting midges in Loreto Department, may involve thousands of persons. Bivouac sites near banana and cacao plantations and forested areas may present increased risk for Oropouche. Use **PPM** against flying insects.

Chagas disease, transmitted in the feces of infected kissing bugs, is associated with substandard housing (e.g., thatch and adobe construction) prevalent in urban slums and rural areas. The disease is present throughout northwestern Tumbes and Amazonas Departments and below 3,500 m in the southern coastal areas of Tacna, Ica, Arequipa, and Moquega Departments. Bivouac away from domestic and peridomestic settings. Use **PPM** to protect against kissing bugs.

Epidemic typhus (louse-borne) occurs in cool mountainous areas of Cuzco and Puno Departments. **Relapsing Fever** (louse-borne) is endemic countrywide where populations are infested with lice. Both diseases proliferate under crowded and unsanitary conditions. Avoid close contact with indigenous people.

Soft-bodied ticks that live in human dwellings transmit tick-borne **Relapsing Fever**. Avoid using potentially tick-infested dwellings of local populations for shelter.

Plague, a bacterial disease transmitted by fleas, is focally enzootic in rural areas above 500 m. From 1992-1994, 1,664 cases of plague were reported in the northwest coastal departments of Cajamarca, Lambayeque, La Libertad and Piura. Avoid bivouacking in rodent-infested habitats and using indigenous dwellings for shelter.

Yellow fever is primarily sylvatic in Peru, occurring in jungles in the central Andean valleys and eastern departments. Outbreaks occurred in 1992 (San Martin and northern Cuzco), 1993 (Ucayali), and 1995 (350 cases, 50% fatal). Ensure yellow fever immunizations are current and use **PPM** against day-biting mosquitoes.

Leishmaniasis, a protozoan disease transmitted in the New World by species of *Lutzomyia* sand flies, is difficult to cure. Leishmaniasis occurs countrywide in rural areas below 3,000 m and in jungle and coastal highlands. A cutaneous form of leishmaniasis called "uta" is endemic along the western slopes of Huanuco and Puno Departments (750-3,000 m), where 10,000 cases were reported in late 1990. Control sand flies with residual insecticides applied within encampment areas and as a barrier treatment. Avoid bivouacking in forested areas. Use **PPM**, particularly from sunset to dawn.

Bartonellosis, a bacterial disease transmitted by sand flies, occurs in Ancash Department, where hundreds of cases and numerous fatalities have been reported. Use **PPM** against sand flies.

Hantavirus is a zoonotic virus contracted by inhaling aerosolized rodent excreta or by handling infected rodents. An unconfirmed human case of hantavirus was reported from the Matarani/Mollendo area. Avoid rodent-infested (particularly enclosed) areas and rodent-contaminated commodities.

Rabies, transmitted by the bite of rabid vampire bats and other animals, is a threat in the vicinity of Yutupis, Amazonas Department, where several human fatalities have been reported. Avoid sleeping in the open and handling wild animals or stray dogs. Individuals bitten by animals should receive immediate medical treatment.

Venomous snakes and arthropods, and plants that are poisonous or cause contact dermatitis are present throughout Peru. Ticks, fleas, chiggers, mosquitoes and other biting flies cause significant discomfort. Severe scratching may result in secondary infections. Use **PPM** and teach troops to recognize and avoid contact with poisonous plants.

II. Map of Peru (CIA)

III. Country Profile

A. Geography. Peru is the third largest country in South America, with a total land area of 1,280,000 km^2 (496,225 mi^2) and 24 political subdivisions designated as departments. It is bordered on the north by Ecuador (1,420 km (880 mi) border) and Colombia (2,900 km (1,798 mi) border), on the east by Brazil (1,560 km (968 mi) border), on the southeast by Bolivia (960 km (595 mi) border), on the south by Chile (160 km (99 mi) border), and in the west by the Pacific Ocean (2,414 km (1,497 mi) coast). Peru consists of three distinct topographical regions: a narrow coastal plain, a mountain range, and an area of tropical rainforests. The coastal plain is a narrow band of arid coastline ca. 50 km (30 mi) wide that merges into the Andean foothills and extends the entire length of the country. Elevations vary from sea level to ca. 1,525 m (5,000 ft), and only 14 of the 50 streams draining into the Pacific Ocean have continuous flow throughout the year. This coastal plain comprises ca. 11% of Peru's total land area. The Andean Mountain ranges (Cordillera Occidental, Central, and Oriental) occupy 26% of the land area. The average elevation is 3,960 m (13,000 ft), with one mountain in the Cordillera Occidental ascending to 6,770 m (22,205 ft). The region east of the Andes consists of mountainous rainforests transitioning to the lowland tropical rain forests of the Amazon Basin, which accounts for 63% of the country. Elevations are 610 m (2,000 ft) or less. Major rivers in the east are numerous and include the headwaters of the Amazon (Rio Napo, Rio Maranon, and Rio Ucayali). Lake Titicaca, located in southern Peru, extends into neighboring Bolivia.

B. Climate. The narrow strip of land extending west from the base of the Andes and south along the entire Peruvian coastline is one of the most arid regions in the world, receiving less than 10 mm (less than ½ inch) of rain annually. Temperatures in this area rarely exceed 30°C (86°F), with lower limits of 9°C (48°F). Lima (Table 1), centrally located on the coast, is representative of the coastal climate. In the Andes, nightly frosts are common during the dry season (May-November in the north and April-November in the south). The southern mountains are slightly cooler and wetter than those in the north (Tables 2 and 3, Cajamarca and Cuzco, respectively), with annual rainfall ca. 800 mm (32 inches). Iquitos (Table 4) is representative of the wet, humid, tropical rainforest present east of the Andes. Annual rainfall is ca. 2,650 mm (106 inches). Flooding caused by daily rains is common during nine months of the year, with a short dry season occurring in July and August. Average minimum and maximum temperatures of 22° and 30°C (72° and 86°F) in the eastern lowlands of the Amazon Basin do not fluctuate more than a couple of degrees centigrade throughout the year.

Table 1. 15-year meteorological summary for Lima (120 m/394 ft).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Highest Temp. (°C)	32	33	33	34	29	27	27	27	26	26	29	31
Av. Maximum (°C)	28	28	28	27	23	20	19	19	20	22	23	26
Av. Minimum (°C)	19	19	19	17	16	14	14	13	14	14	16	17
Lowest Temp. (°C)	15	15	16	13	11	9	9	10	11	12	11	13
Av. Rainfall (mm)	3	0	0	0	5	5	8	8	8	3	3	0

Table 2. 9-year meteorological summary for Cajamarca (2,640 m/8,662 ft).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Highest Temp. (°C)	25	25	26	25	25	25	25	26	25	26	26	26
Av. Maximum (°C)	22	21	21	21	22	21	21	22	22	22	22	22
Av. Minimum (°C)	9	9	9	8	7	6	5	6	7	8	8	8
Lowest Temp. (°C)	4	0	3	0	-1	-1	-2	-1	0	1	-1	-4
Av. Rainfall (mm)	91	107	117	86	43	13	5	8	58	58	48	81

Table 3. 13-year meteorological summary for Cuzco (3,225 m/10,581 ft).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Highest Temp. (°C)	28	27	26	26	26	25	25	25	27	29	28	27
Av. Maximum (°C)	20	21	21	22	21	21	21	21	22	22	23	22
Av. Minimum (°C)	7	7	7	4	2	1	-1	1	4	6	6	7
Lowest Temp. (°C)	3	2	2	-4	-4	-5	-9	-5	-1	-1	1	1
Av. Rainfall (mm)	163	150	109	51	15	5	5	10	25	66	76	137

Table 4. 18-year meteorological summary for Iquitos (120 m/394 ft).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Highest Temp. (°C)	36	37	36	35	37	37	36	37	40	36	38	36
Av. Maximum (°C)	31	30	30	30	30	29	29	30	31	31	31	31
Av. Minimum (°C)	22	22	22	22	22	22	21	22	22	22	22	22
Lowest Temp. (°C)	20	20	19	20	17	13	13	13	15	16	16	20
Av. Rainfall (mm)	266	254	299	302	266	208	162	165	190	231	248	259

C. Population/People. Approximately 90% of Peru's 25,000,000 inhabitants reside on the coastal plain (40%) and in the highlands of the Cordillera Central (50%). The remaining 10% are sparsely scattered along the eastern front of the Andes extending into the vast Amazon River drainage system. The largest cities are Lima (>6,200,000), Callao (687,000), Arequipa (668,000), Trujillo (548,000), Comas (287,000), Chiclayo (280,000), Cuzco (277,000) and Iquitos (>200,000). Seventy-two percent of the populace lives in urban areas.
Ninety percent of the population is Roman Catholic, with ethnic groups totaling 45% Indian, 37% Mestizo (mixed Indian and European ancestry), 15% white, and 3% Black, Japanese, Chinese, and others. The official languages are Spanish, Quechua, and Aymara. The literacy rate is approximately 85%.

D. Living and Sanitary Conditions. Living and sanitary conditions are poor. Squatters in urban areas rarely have municipal sewer services. Lima and other urban areas have insufficient refuse collection. An estimated 20% of the 5,000 tons of solid waste produced daily in Lima is collected and taken to one major landfill. The remainder is disposed of indiscriminately. Food sanitation practices are below Western standards.

1. Pollution: Water contaminated with sewage, mining waste and run-off is the country's principal pollution problem. Municipal sewage disposal systems are below Western standards, with most waste going directly to nearby rivers, beaches, and coastal waters. Wastes from the mining of copper, lead, silver and zinc also pollute waterways and coastal waters, contributing to poor water quality.

2. Water: Surface waters (lakes, rivers, and streams) are major water sources for Peruvians. Wells are a less important source of water. Water treatment is minimal. Poor maintenance, back siphonage, and frequent breakdowns of the water distribution system also contribute to contamination. An estimated 25% of Peru's urban residences lack municipal water connections. Use tap water for drinking only after boiling or treatment for bacterial and protozoan contamination.

IV. Militarily Important Vector-Borne Diseases with Short Incubation Periods (<15 days)

A. Malaria. Malaria is a protozoan blood parasite transmitted to man by the bite of infective *Anopheles* mosquitoes. There are four species of human malaria (*Plasmodium falciparum*, *P. vivax*, *P. malariae*, and *P. ovale*), and all except *P. ovale* occur in Peru. *Plasmodium falciparum*, the most serious of the four malarias, frequently causes death (10% in untreated non-immune adults). *Plasmodium vivax* and *P. malariae* are generally not life threatening but may result in complete debilitation during manifestations of clinical symptoms. Some specialized *P. vivax* parasites (hypnozoites) may remain hidden in the liver cells for months or even years following initial clinical disease. Consequently, relapses producing clinical malaria may occur months to years later. *Plasmodium malariae* parasites occasionally remain in the blood at undetectable levels, replicating and causing disease at some later date. Relapses usually do not occur with *P. falciparum*. Lack of treatment, drug resistant strains, or inadequate therapy may result in relapses of all malaria species. Clinical disease symptoms of malaria vary with the species. Symptoms of *P. falciparum* malaria may include fever, chills, sweats, cough, diarrhea, respiratory distress and headache, often leading to more serious systemic complications. *Plasmodium vivax* and *P. malariae* cases may begin with general malaise and a slowly rising fever of several days duration, followed by shaking chills, rapidly rising temperature usually accompanied by headache and nausea, and end in profuse sweating. The initial fever subsides for a period and is followed by subsequent cycles of fever, chills, and sweating.

1. Military Impact and Historical Perspective. The annual number of malaria cases in Peru has tripled since the middle 1980s, with 122,039 reported in 1994 (based on positive blood smears). Approximately three times as many cases were reportedly treated through governmental malaria control programs. Private sector care and self-treatment cases are not included. The overall incidence increased from 5.5/1,000 in 1986 to 11/1,000 in 1994, with the highest incidence in the departments of Ucayali (109/1,000) and Lambayeque (57/1,000). *Plasmodium falciparum* is increasing and in some areas accounts for ca. 50% of all malaria cases, especially in the Amazon Basin. Increased populations and distribution of *Anopheles darlingi* may account for the increases in *P. falciparum* malaria. Risk is countrywide and year-round at elevations less than 1,500 m (above 2,000 m in Ancash Department). Malaria at higher elevations in the Andean valleys begins to occur at the end of the rainy season (April), coinciding with increased populations of *An. pseudopunctipennis*. In summary, the threat of malaria in Peru is equal to that faced by the Army during the Vietnam conflict. Furthermore, *P. falciparum* resistance to antimalarial drugs would compound the threat. Thus, as in Vietnam, commanders could lose two of every five men to malaria. Malaria is largely preventable and casualties can be minimized with the application of suppression measures outlined in paragraph IV.A.4.

2. Transmission Cycle. Humans are the sole reservoir for and female mosquitoes of the genus *Anopheles* are the exclusive vectors of human malaria. During feeding, the mosquito ingests the sexual stages of the parasite (male and female gametocytes), which unite and form an ookinete that penetrates the midgut, forming an oocyst. The oocysts produce thousands of sporozoites, some of which migrate to the salivary glands and are injected into the human host on subsequent feedings. The time between ingestion of sexual gametocytes and liberation of sporozoites is dependent on the temperature and species of malaria parasite (8-35 days). Cooler temperatures, such as those that occur at higher altitudes, will increase the time for development. The ingested sporozoites travel to the liver, where they invade the liver cells, divide, and become asexual merozoites. After several divisions, the merozoites leave the liver cells and parasitize individual red blood cells (RBCs). Most become schizonts that cyclically rupture the RBCs, causing the characteristic symptom of "fever and chills." Some merozoites develop into sexual male and female gametocytes capable of infecting other *Anopheles* mosquitoes. Patients may infect mosquitoes 1-2 days after the onset of symptoms of *P. vivax* malaria, whereas 10-12 days are required for *P. falciparum*. Once infected, mosquitoes remain so for life. Infected humans are potential reservoirs of infection as long as the sexual gametocytes are circulating in the blood.

3. Vector Ecology Profile. Important vectors of malaria in Peru are *An. albimanus*, *An. calderoni*, *An. darlingi*, *An. pseudopunctipennis*, *An. nuneztovari*, *An. benarrochi*, *An. mediopuctatus*, *An. triannulatus*, and *An. trinkae*. Relative importance may be determined by seasonal and/or geographic distribution. Ecology profiles for these species are presented in Appendix A.1. Increasing knowledge of anopheline species in the Americas indicate the existence of sibling species complexes. Populations previously considered *An. punctimacula* along areas of the Pacific coast are now recognized as *An. calderoni*. Lists of mosquitoes from Peru, and keys for their identification are presented in Appendices B.1 and G, respectively.

4. Vector Surveillance and Suppression. Larval and adult surveillance techniques are use to assess mosquito populations. Consult the vector ecology profile for mosquito species of concern and adapt larval surveys to breeding habitats of these species. Larval sampling using a white, long handled dipper will facilitate collection of *Anopheles* larvae. Systematically performed, larval dipping can provide data on species composition and population dynamics on which to base control measures. Adult surveillance of potential anopheline vectors principally involves collection on animal or human bait, or capturing resting adults using mechanical or mouth aspirators. (Note: Collections using human bait must be conducted under approved human-use protocols.) Military operations may be more concerned with exophilic anopheline populations, necessitating the collection of mosquitoes away from domestic locations. Anthropophilic species can be collected in human dwellings with an aspirator aided by a flashlight. Collections from any source are suitable for determining species composition and abundance, parity rates, and malaria parasite infection rates. The older the female anopheline mosquito population in a malaria-endemic area, the greater the potential for transmission, since the human-mosquito-human cycle requires a minimum of 8-9 days. Malaria suppression should include elimination of gametocytes from the human reservoir population, reduction of *Anopheles* populations, and prevention of mosquito bites. Mosquitoes are capable of acquiring *P. vivax* gametocytes from infected humans for 24-36 hours after treatment with chloroquine alone, but when treated concurrently with chloroquine and primaquine, the acquisition period is reduced to less than four hours. *Plasmodium falciparum* gametocytes are not killed by Fansidar®, quinine, or quinine plus tetracycline. Patients are known to infect mosquitoes for more than 30 days after successful treatment of erythrocytic stages. Primaquine is required to kill gametocytes and reduce transmission to new mosquito reservoirs. In Peru, chloroquine and Fansidar® resistant *P. falciparum* is reported in the departments bordering Brazil and eastern Ecuador (Loreto and Madre de Dios), with resistance indicated in the departments of Apurimac and Cuzco. There are Fansidar® and Mefloquine-resistant strains in the extreme east bordering Brazil. Mefloquine resistance is suspected to occur in the Amazon Basin of Peru. It is critically important for commanders to enforce medical protocols when antimalarial drugs are indicated. Reduction of mosquito populations can be accomplished by chemical control techniques (larval and adult). Consult TIM 24 for chemicals, equipment and procedures for controlling larval and adult mosquitoes. *Anopheles pseudopunctipennis* was described as resistant to DDT in a 1992 WHO report and to Dieldrin and HCH in earlier WHO reports. **Personal Protective Measures** to prevent mosquito bites include minimizing exposed skin by wearing permethrin-treated BDUs with sleeves down (particularly after sundown), using extended-duration deet repellent, arthropod repellent deet jackets and headnets treated with deet, and sleeping under permethrin-treated bednets, whenever possible (TIM 36).

B. Dengue Fever. Dengue fever is a viral illness (Flavivirus: Flaviviridae) transmitted in the Americas by the bite of the *Aedes aegypti* mosquito. Symptoms of dengue ensue 3-14 days following the bite of an infective mosquito. They include sudden onset of fever, severe headache, muscle and joint aches, retro-orbital pain, loss of appetite, gastrointestinal upset and, in some cases, generalized erythema and rash. There are four serotypes of the dengue virus (DEN-1, 2, 3 and 4). Serotypes are extremely important when considering clinical illness. There is lifelong immunity to subsequent exposure to the same (homologous) serotype, whereas an individual is predisposed to the more serious and often fatal dengue hemorrhagic fever (DHF), or dengue shock syndrome (DSS), if exposed to a different (heterologous) serotype. There are no vaccines for protection against the dengue virus.

1. Military Impact and Historical Perspective. The first outbreak of dengue in Peru occurred from March to July 1990 in Iquitos and surrounding areas of Loreto Department, and a second occurred in Tarapoto, San Martin Department. A total of 7,858 cases of dengue fever (DEN 1 and 4) were reported between the two outbreaks, with no cases of DHF/DSS. As dengue spreads south from northern South America, more epidemics can be expected in urban areas below the elevational limits of *Ae. aegypti* (ca. 2,000 m). Dengue fever is capable of inflicting many casualties and rendering soldiers unfit for duty for a week or more. While morbidity rates for nonimmune personnel are high, complications of DHF/DSS are uncommon. During operations in endemic urban and peri-urban locations, it is crucial to use personal protective measures to repel day-biting *Ae. aegypti.*

2. Transmission Cycle. Both humans and mosquitoes serve as reservoirs in the human-mosquito cycle. *Aedes aegypti*, the primary vector of dengue in the Americas, may acquire the virus from a viremic person immediately prior to and during the febrile period (about 6-7 days). The mosquito is able to transmit the virus 8-12+ days after acquisition, depending on temperature, and remains infective for life. Although *Aedes albopictus*, an additional potential vector of the dengue virus, is currently not found in Peru, it occurs in Tabatinga, Brazil, along the eastern border of Peru.

3. Vector Ecology Profile. The vector ecology profile for *Ae. aegypti* and *Ae. albopictus* are presented in Appendix A.2.

4. Vector Surveillance and Suppression. Control of dengue fever is contingent upon managing populations of *Ae. aegypti* through surveillance, reduction of breeding sources, treatment with insecticides, and personal protection. Surveillance should include monitoring adult egg-laying activity using black oviposition cups, searching interiors and exteriors of urban and peri-urban premises and encampment sites for water-filled containers harboring *Ae. aegypti* larvae, and conducting landing counts (TB MED 561). Eliminate breeding sources (any receptacle that may hold fresh water) from premises and encampment sites. Broad-area control of adult populations can be obtained using ULV equipment and thermal foggers. Consult TIM 24 for equipment and chemicals for control of mosquitoes. Cooler morning and evening hours are optimal times for applying fogs and aerosols to prevent the chemicals from being carried away by temperature-induced updrafts. Widespread resistance to organophosphates (chlorpyrifos, dimethoate fenthion, malathion and temephos) has been reported for *Ae. aegypti* (WHO 1992). The individual soldier can best prevent dengue fever by using **Personal Protective Measures** during the day, when *Ae. aegypti* frequently bite. Wear permethrin-impregnated BDUs and use extended-duration deet repellent on exposed skin surfaces (TIM 36). Avoid the practice of stripping to the waist or wearing shorts to keep cool during the daytime.

C. Yellow Fever. Yellow fever is caused by a flavivirus transmitted by mosquitoes. Symptoms of yellow fever occur 3-6 days following the bite of an infected mosquito. Patients may be nearly asymptomatic, but generally symptoms begin with sudden onset of fever, chills, headache, backache, generalized muscle pain, prostration and vomiting. Symptoms may progress to jaundice and hemorrhagic manifestations. Fatalities may exceed 50% in non-indigenous or non-immunized individuals. Yellow fever imparts a lifelong immunity to survivors.

1. Military Impact and Historical Perspective. In the Americas, virtually all cases of yellow fever in the past 55 years can be attributed to the sylvatic cycle. Extensive *Ae. aegypti* eradication programs largely eliminated the disease from urban areas, but in recent years, populations of *Ae. aegypti* have reestablished themselves in the country's urban centers. Significant outbreaks of urban yellow fever are probable in the future. The sylvatic cycle continues as focal enzootics and epizootics among native species of *Haemagogus* and *Sabethes* mosquitoes and a number of primate species. These occur mostly in the eastern areas of the Amazon River Basin (Loreto and Madre de Dios Departments) and in forested areas on the Andean slopes (Amazonas, Ancash, Ayacucho, Cuzco, Huanuco, Junin, Puno, Pasco, San Martin and Ucayali Departments). An outbreak of 350 cases was reported by PAHO in 1995 in 7 departments (locations not specified). The yellow fever vaccine offers immunized soldiers essentially 100% protection; however, host country soldiers may not have the same protection and may require entomological support.

2. Transmission Cycle. Yellow fever is propagated in either an urban cycle or a sylvatic cycle. During the urban cycle, the virus is transmitted between mosquitoes and humans. The sole mosquito vector is the domestic *Ae. aegypti.* Mosquitoes may acquire the virus from an infected person immediately prior to the onset of fever and 3-5 days after. Mosquitoes require 9-12 days to become infective, and remain so for life. The sylvatic cycle is a mosquito-monkey cycle. Primary vectors include canopy-dwelling species of *Haemagogus* and *Sabethes*, which transmit the virus to monkeys of the family Cebidae (howler monkeys, *Alouatta* spp.; and spider monkeys, *Cebus* spp., *Aotes* spp. and *Callithrix* spp.). Maintenance of the virus in the sylvatic cycle is enhanced by transovarial transmission among the vector mosquitoes. Urban yellow fever occurs when humans enter the jungle cycle, contract the disease from *Haemagogus* or *Sabethes* mosquitoes, and return to urban areas where they infect *Ae. aegypti* that subsequently bite other urban residents. In the urban setting, humans are amplifying hosts for the virus.

3. Vector Ecology Profile. *Aedes aegypti* is the primary vector of yellow fever in the mosquito-man urban cycle. The vector ecology profile for *Ae. aegypti* is presented in Appendix A.2. In Peru, *Haemagogus janthinomys* is the principal vector in the sylvatic cycle (monkey-mosquito-human). Vector ecology profile for this species is also presented in Appendix A.2.

4. Vector Surveillance and Suppression. Methods for surveillance and suppression of yellow fever in the urban environment are the same as for dengue. Transmission of sylvatic yellow fever can be prevented by vaccination and using **Personal Protective Measures** to prevent species of *Haemagogus* and *Sabethes* from biting. Wear permethrin-impregnated BDUs with sleeves rolled down and use extended-duration deet repellent on exposed skin surfaces, especially during the daytime when these mosquitoes actively bite (TIM 36 and Appendix H). Avoid the practice of stripping to the waist or wearing shorts to keep cool during the daytime. Select bivouac areas as far from forests as the tactical situation permits.

D. Other Arboviral Fevers. Dengue fever, paragraph IV.B., and yellow fever, paragraph IV.C., are described in greater detail than the following arboviral diseases because of detailed knowledge of their epidemiologies and potential for producing severe hemorrhagic disease. Other arboviral diseases only cause systemic febrile illness or encephalitis. Eastern equine encephalitis (EEE) warrants special comment because of its potentially high mortality. Most individuals that contract EEE do not show clinical symptoms (90-95%); however, ca. 50% fatalities occur among those that do. Survivors that become clinically ill usually suffer significant permanent neurological damage. EEE was the most common virus isolated (30-40%) in a forest near Iquitos by U.S. military researchers in 1997. Most isolates were from *Culex* (*Melanoconion*) *pedroi* (80%), while the rest were from *Psorophora ferox*. In general, arboviral fevers in Peru are poorly understood; but, some may inflict high morbidity, especially in non-immune personnel. Incapacitation can occur rapidly, lasting a few days to several weeks. Although the clinical symptoms differ slightly for each, they generally consist of fever, headache, dizziness, arthralgia, myalgia, often a rash, and occasional prostration. Documented Peruvian arboviruses include the Togaviridae (Alphaviruses): Eastern equine encephalitis (EEE), Mayaro, Una (Mayaro-like), Western equine encephalitis (WEE), Venezuelan equine encephalitis (VEE); Flaviviridae (Flaviviruses): Bussuquara, Ilheus, St. Louis encephalitis (SLE); and Bunyaviridae (Bunyaviruses) Anopheles A Group: Tacaiuma; Group C: Apeu, Caraparu, Itaqui, Marituba, Murutucu, Oriboca; California Group: Guaroa, Nepuya, Gumbo Limbo, Bunyawera; Guama Group: Guama, and Simbu Group: Oropouche. Arboviruses that occur in Peru or that may be present east of the Andes in lowland tropical areas geographically contiguous with the Amazon Basin are listed in Appendix A.3. Potential vectors and reservoirs identified throughout the Amazon Basin (including some known in Peru) are included in the appendix. Vaccines are not available for these arboviral diseases. Prevention of human cases includes control of mosquitoes, use of repellents (day and night) and bed nets, and avoidance of forest habitats.

1. Oropouche. Oropouche occurs in either a sylvatic (forest) cycle or an urban cycle. Little is known about the sylvatic cycle, although primates, sloths, and possibly wild birds are implicated reservoirs. The biting midge, *Culicoides paraensis*, is a proven vector. *Culex quinquefasciatus* is also capable of transmission but is considered to be of minor importance. Vector ecology profiles for *C. paraensis* and *Cx. quinquefasciatus* are presented in Appendix A.3. Epidemics involving hundreds of thousands of people have occurred in the Amazon Basin of Brazil. Oropouche virus may inflict rapid, extensive, and high morbidity in military personnel. Explosive outbreaks occur in urban areas and rural villages, especially those near banana and cacao crops. A 1997 report indicates 28% of the rural residents in the Amazon Basin near Iquitos (elevation 120 m), Loreto Department, seroconverted to Oropouche after one year, while only 2% seroconverted in urban and forest communities. High populations of *C. paraensis* were associated with areas of high seroconversion. U.S. military entomologists in Brazil noted that insecticide applications in cacao and banana plantations for other agricultural pests drastically reduced populations of *C. paraensis*. Residual pesticides can be directed at breeding areas at any time, while aerosol applications should be applied during peak host seeking activity, approximately an hour before sunset. Maintain good sanitation by eliminating wet and deteriorated vegetation (e.g., banana tree stalks and stumps, discarded cacao pods) that could provide breeding sites for *Culicoides*. Using extended duration deet repellent and keeping trousers tucked into boots will prevent bites. Avoid lying on the ground during the day, as individuals that do so while in the life zone of *Culicoides paraensis* are at greater risk of being bitten. Do not camp in or adjacent to banana or cacao plantations.

2. Venezuelan Equine Encephalitis (VEE). Mosquitoes transmit enzootic and epizootic VEE. Enzootic subtypes of the virus have reduced pathogenicity in horses and are infrequently recognized. Epizootic subtypes produce severe illness in horses and produce high viremias capable of infecting vector mosquitoes. Either enzootic, or epizootic subtypes of VEE can produce severe disease, encephalitis, and death in humans. Human cases usually follow the beginning of an epizootic in horses by about two weeks. Nearly all genera of mosquitoes are capable of transmitting VEE, but in Peru *Ae. scapularis*, *Ae. taeniorhynchus*, *Cx. ocossa*, *Ma. titillans*, *Ma. indubitans* and *Psorophora albigenu* are incriminated vectors. Vaccinating the equine population and killing larval and adult mosquitoes with insecticides (TIM 24) controls VEE epidemics. Immunity to epizootic VEE in horses is complete within 5 days of vaccination. During March - June 1994, Peruvian army troops operating in the tropical rain forest of Pantoja, Peru, contracted VEE and Oropouche. These were the first reported human cases of VEE in the Amazon region of Peru. Previously outbreaks occurred in the central and northern coastal plains bordering Ecuador. Human cases of VEE were last reported in the coastal plains in 1973. In 1997, army researchers isolated VEE virus from forest mosquitoes in Peru. Sporadic cases of sylvatic VEE are possible in forested areas infested by species of *Culex* (*Melanoconion*) when virus is enzootic in rodent and bird populations. References containing for keys to species of *Culex* (*Melanoconion*) are provided in Appendix G.

E. American Trypanosomiasis (Chagas Disease). Chagas disease is the second most important arthropod-borne disease in the country in terms of the number of persons infected and impact of prolonged morbidity. This disease is caused by *Trypanosoma cruzi*, a flagellated protozoan that is transmitted by infected conenose or kissing bugs of the family Reduviidae. It is an insidious disease with variable symptoms in the acute phase, ranging from no clinical symptoms to unilateral facial edema (Romana's sign) usually at the site of bite(s), fever, malaise, lymphadenopathy, and enlarged liver and spleen. Symptoms generally appear 5-14 days after infection. Chronic symptoms persist for many years and usually involve the heart, intestinal and autonomic nervous systems. Involvement of these organ systems results in extensive lingering morbidity and 20% fatalities. A second protozoan (*Trypanosoma rangeli*) is often present in vector species but has not been linked to human disease. Xenodiagnosis (blood feeding of "clean" bugs on a patient, waiting for several weeks, and examining the bug's feces for trypanosomes) is used for diagnosis, especially during the chronic phase of the disease when the number of trypanosomes in the blood is low. An indirect fluorescent antibody technique is also available for testing blood and spinal fluid for *T. cruzi* antibodies. Trypanosomes present in blood may be transmitted during blood transfusions.

1. Military Impact and Historical Perspective. Chagas disease is associated with poverty, primarily in rural areas, although slums and the periphery of urban areas may also be affected. The disease is endemic in the southwestern departments of Arequipa, Ica, Moquegua, Tacna, and the northern departments of Tumbes, Piura and Amazonas. Endemic foci were recently identified in the neighboring Ecuadorian provinces of Napo and Sucumbios bordering northwestern Loreto Department. The disease is likely found in similar habitats of Loreto's tropical lowlands. Since soldiers operate in the forest, the likelihood of exposure to Chagas disease by extradomiciliary vector species might be greater than exposure in a domestic setting. In addition, the disease has the potential to infect many troops that bivouac adjacent to or in areas with substandard housing (e.g., makeshift and palm thatched construction). Avoid such areas and use **Personal Protective Measures** to prevent biting bugs and thus minimize risk. Because serious symptoms are delayed, the greatest impact will be on the individual soldier and the medical support system subsequent to deployment.

2. Transmission Cycle. Humans are important reservoirs of the parasite, *T. cruzi*, as are many domestic and peridomestic animals (e.g., dogs, cats, guinea pigs, and swine). Hosts differ depending on locality and vector species. Some sylvatic kissing bugs will feed on humans who enter their habitats, but they are usually considered important only in maintaining the cycle in nature. When kissing bugs feed on infected humans, trypanosomes are ingested and begin to replicate in the hindgut. The bug becomes infective 10-30 days after feeding on an infected host and remains infected for life (as long as two years). Kissing bugs may also acquire trypanosomes while feeding on infected blood in the abdomen of other engorged bugs. All stages of the bug may become infective. Human infections occur when bugs defecate on the skin of their host during feeding and the infected feces are rubbed into the bite puncture or abrasions, or onto the mucosae of the eyes, mouth, or nose. The most important vectors of Chagas disease live in association with man in domestic or peridomestic settings, inflict nearly painless bites, and defecate on the host. Species with delayed patterns of defecation (feed and leave before defecating) are incapable of transmitting trypanosomes. Triatomines feed on humans only at night and particularly on the neck and face.

3. Vector Ecology Profile. Vector ecology profiles for the Peruvian species *Triatoma infestans*, *T. dimidiata*, *T. carrioni*, *Panstrongylus herreri*, *P. chinai* and *Rhodnius ecuadoriensis* are presented in Appendix A.4. A list of the species of Reduviidae that occur in Peru is provided in Appendix B.3.

4. Vector Surveillance and Suppression. Surveillance of triatomines is best conducted at night with the aid of a flashlight. Host-seeking bugs (adults and nymphs) can be detected crawling in the open, particularly around sleeping areas, guinea pig enclosures, and livestock shelters. Harborage for triatomine bugs, such as cracks and crevices of adobe walls, wood, and thatched roofs, should also be checked carefully. Bug fecal stains on walls are another sign of infestations. Light traps are ineffective as a surveillance tool for Reduviidae, although some sylvatic species are attracted to domestic light sources. Should chemical control become operationally feasible or necessary, spraying of interior surfaces of walls, cracks and crevices, overhead thatching, rafters, and under bed structures will control bug populations. Deltamethrin has been used successfully for controlling *T. infestans* in domestic and peridomestic situations. Fenitrothion resistance among *T. infestans* has been reported in Peru (WHO). Risk of contacting vectors is greatest in or near dwellings with abundant cracks and crevices (e.g., thatch, adobe, or makeshift shanty construction) and domestic animal shelters (e.g., livestock, chickens, pigeons, etc.). Sylvatic species are potential biters also. Avoid sleeping near palm trees because they may harbor kissing bugs. During sleep, keep as much of the body covered as possible and use extended-duration deet repellent on exposed skin surfaces. Headnets and bednets used to prevent mosquito/sand fly-borne diseases will exclude night-feeding kissing bugs (TIM 36).

F. Epidemic Typhus. The agent of epidemic or louse-borne typhus, *Rickettsia prowazekii*, is transmitted in the feces of infected body lice (*Pediculus humanus corporis*) and not by the bite of the louse. Symptoms 7-14 days post-infection include headache, followed by fever, chills, prostration and general body aches. A macular rash usually appears on the upper trunk and spreads to the entire body. Failure to treat with antibiotics may result in 10-40% fatalities.

1. Military Impact and Historical Perspective. The disease is endemic throughout the Andean cordilleras among Indian populations. Historically, most cases occur between March and September. Data is scanty after the late 1970s because the disease is no longer reportable. The potential for outbreaks among the indigenous population would be great when military operations result in concentrations of refugees or prisoners of war, but few cases would be expected among U.S. soldiers using routine **Personal Protective Measures**. The Department of Defense no longer has the capability to mass delouse refugees, displaced persons, and other civilians using insecticidal dusts with power-driven application equipment. Although DoD does not have a delousing method using insecticidal dusts, a variety of other methods might be warranted to delouse refugees, displaced persons, and other civilians during emergencies. These methods include administering oral or topical pediculicides, washing or replacing clothing, and applying repellents. Since the specific methods may not all be approved in the U.S., their use during emergencies should be at the discretion of the Joint Task Force Surgeon after consultation with non-governmental organizations (such as the World Health Organization) and host nation officials. The current options may create logistical burdens on U.S. forces. Control of body lice must be concurrent with louse-borne disease control. Additionally, U.S. soldiers may only use insecticides or pediculicides labeled for use by the U.S. Environmental Protection Agency or the U.S. Food and Drug Administration.

2. Transmission Cycle. Transmission is confined to the louse-human-louse cycle. Humans are the reservoir of *R. prowazekii* and the sole host for the human body louse, *P. h. corporis*. During the febrile period and for 2-3 days after, lice may acquire rickettsiae while feeding. Louse feces become infective 2-6 days thereafter. The louse usually dies within two weeks from pathological effects of the rickettsiae. During the life of the infective louse, rickettsiae are excreted in the feces while feeding and the feces (or the crushed louse) are subsequently rubbed into the bite or other abraded areas, infecting the individual. Infection may also occur by inhalation of infected louse feces. Some people suffer a mild form of the disease (Brill's disease) and become asymptomatic carriers, relapsing and introducing the disease into healthy populations many years later.

3. Vector Ecology Profile. Female lice produce 4-5 eggs per day. Eggs adhere to clothing and can be found in the seams. Eggs are not viable for more than four weeks, and lice survive for only a few days without a blood meal; therefore, clothing discarded for a month or more poses no danger of infestation. Eggs hatch in about 7 days and the nymphs undergo three molts, maturing to adults in 18 days. Male and female nymphs and adults, each feed several times per day. Transfer of lice occurs by direct contact or via infested clothing. Unsanitary conditions and overcrowding caused by social or cultural events, natural disasters, or conflicts resulting in concentrations of refugees or prisoners of war, may result in epidemics. The disease is endemic in cooler climates associated with the inter-Andean cordilleras.

4. Vector Surveillance and Suppression. Surveillance for body lice involves examination of suspected individuals and their clothing. Outbreaks of epidemic typhus among local populations are indicative of infestations. Soldiers should avoid contact with local populations. Suppression of the disease by individual soldiers and prisoners of war involves application of permethrin to BDUs and personal clothing, and maintaining a high level of personal hygiene (frequent bathing and laundering of clothing). The DoD currently relies on permethrin-treated uniforms to repel and control body lice on soldiers and prisoners of war.

G. Relapsing Fever (tick-borne). The etiologic agents of tick-borne endemic relapsing fever are species of *Borrelia* transmitted by soft-bodied ticks in the genus *Ornithodoros*. The *Borrelia* strains are specific for the area and species of host tick. The disease in humans is the same as in louse-borne relapsing fever.

1. Military Impact and Historical Perspective. Epidemiological information is unavailable, but limited enzootic foci are likely where vector tick species occur. Exposure to biting soft-bodied ticks is unlikely, but isolated cases are possible. Personnel should avoid using the potentially tick infested dwellings of local populations for shelter.

2. Transmission Cycle. The soft-bodied tick, *Ornithodoros rudis*, is the vector of the spirochete *Borrelia venezuelensis*. Humans and ticks are the primary reservoirs. Rodents play a minor role as hosts, since ticks only feed on them opportunistically. *Ornithodoros rudis* spends its life in dry, primitive or makeshift human habitations. The spirochete invades the hemocoel, salivary glands, coxal glands, and ovaries of the host tick within 3-4 days after the tick has fed on an infected human (or, occasionally, rodents). Transovarial transmission of the spirochete occurs, but transmission is maintained mostly between humans and ticks. Once infected, the tick remains so for life. Transmission occurs by the bite of infected ticks or from spirochete-laden coxal fluid that enters through broken or even intact skin.

3. Vector Ecology Profile. *Ornithodoros rudis* and other *Ornithodoros* ticks lay eggs following a blood meal. The eggs hatch into six-legged larvae and multiple molts occur during development to the adult stage. The ticks live for 2-5 years or more. All stages and both sexes of the tick feed at night. They feed quickly and return to their hiding places. Unlike most other *Ornithodoros* ticks, *O. rudis* is considered a parasite of man and is less dependent on rodents.

4. Vector Surveillance and Suppression. The need for surveillance and suppression is unlikely, but visual inspection of cracks, crevices, thatching, walls and floor spaces may reveal infestations, particularly in sleeping areas. Residual pesticides applied to sites of infestation will eliminate ticks (TIM 24). Troops should avoid utilizing indigenous shelters or caves for overnight bivouac sites. Use **Personal Protective Measures** when potential exposure cannot be avoided, particularly at night when *Ornithodoros* ticks feed.

H. Relapsing Fever (louse-borne). The etiologic agent of louse-borne epidemic relapsing fever is *Borrelia recurrentis*, which is transmitted by the human body louse, *Pediculus humanus humanus*. Relapsing fever, as its name implies, is a series of fevers interrupted by afebrile periods. The initial incubation period is 5–15 days, and fevers last for 2-9 days followed by an afebrile period of 2-4 days. The febrile/afebrile sequence may continue for up to 10 cycles. Mortality rates vary from 2-10% for untreated cases.

1. Military Impact and Historical Perspective. Evidence of endemicity is lacking, but the disease probably occurs countrywide in human populations that are infested with body lice, particularly in the mountain valleys where epidemic typhus is focally endemic. Follow the precautions outlined under epidemic typhus, paragraph IV.F.

2. Transmission Cycle. The transmission cycle for louse-borne relapsing fever is similar to that of epidemic typhus. Humans are the reservoir of *B. recurrentis* and the only host for the human body louse, *P. h. humanus*. The louse becomes infective 4-5 days after feeding on an infected human. Imbibed spirochetes quickly pass out of the gut and into the hemolymph, where they proliferate. The spirochetes do not kill the louse as rickettsiae do in epidemic typhus. Feces of the louse are not infected, nor are spirochetes transmitted via the bite. Transmission occurs only by rubbing infected hemolymph of a crushed louse into the bite or other abraded areas. Infective lice remain so for the duration of their lives (20-40 days).

3. Vector Ecology Profile. See epidemic typhus, paragraph IV.F.3.

4. Vector Surveillance and Suppression. See epidemic typhus, paragraph IV.F.4.

I. Plague. Plague is a zoonotic bacterial disease transmitted by the bite of infected fleas. The etiologic agent is *Yersinia pestis*. Clinical manifestations include three forms: bubonic, septicemic, and pneumonic. Bubonic plague has an incubation period of 1-7 days. At onset, symptoms may include fever, chills, malaise, myalgia, nausea, prostration, sore throat and headache. As the disease progresses, buboes teeming with plague bacilli frequently develop in nodes of the lymphatic system closest to the infected bite. Since most bites occur from the waist down, it is typical for buboes to develop in the inguinal region (90%), but they may also occur in the axillary or neck regions. The septicemic stage occurs when the bacillus enters the blood stream, where it shortly disseminates to the lungs and becomes pneumonic. The pneumonic stage is particularly dangerous for the patient and for others who might become infected by aerosol droplet transmission. Such secondary cases develop highly infectious pneumonic plague without buboes or septicemia. Epidemics from pneumonic transmission can quickly develop, especially among healthcare providers and closely associated groups. Untreated bubonic plague has a 50-60% fatality rate, while septicemic and pneumonic cases are usually fatal if not treated early.

1. Military Impact and Historical Perspective. In the early 1900s, Peru experienced plague outbreaks in port and coastal cities as far north as Tumbes and south to Mollendo. Since the 1930s, outbreaks have occurred primarily in northern cities and rural areas in the departments of Cajamarca, La Libertad, Lambayeque, and Piura. From 1978-92, 120 cases were reported, and in October 1992 a major outbreak, lasting through September 1994, causes 1,664 cases. A vaccine is available that provides limited protection from the disease but is currently recommended only for personnel working with plague organisms or with potentially plague-infected rodents. Sporadic cases might be expected during military operations in urban populations, where plague has occurred or is occurring.

2. Transmission Cycle. Plague has two transmission cycles: sylvatic and urban. Sylvatic plague is zoonotic in a wild rodent-flea cycle. Wild rodents and their fleas usually perpetuate the plague cycle unnoticed in plague-endemic foci. Some rodents are refractory to the effects of plague, thus maintaining the cycle in nature, while others are susceptible, resulting in epizootics and die-offs of susceptible populations. When humans enter the domain of a sylvatic cycle, infected fleas may bite them. Such cases are sporadic and focal. Urban plague occurs when domestic rodents come in contact with plague-infected sylvatic rodents and/or their fleas. Urban plague is maintained primarily between species of *Rattus* and their fleas within the domestic environment. Close association of large human populations and *Rattus* spp. may result in rapid transmission and outbreaks of epidemic proportions. Transmission of the plague bacillus by fleas is species-specific. Not all fleas are competent vectors. *Xenopsylla cheopis* is the principal vector of urban plague worldwide. Its efficiency as a vector can be attributed to the number and structure of proventricular spines and to enzymes produced by the plague bacilli. *Yersinia pestis* in the stomach and proventriculus of *X. cheopis* initiates production of a trypsin-like enzyme and coagulase that causes blood to coagulate and block the proventriculus at ambient temperatures below 27°C. Such proventricular blockage promotes inoculation of plague bacilli during repeated unsuccessful attempts to feed. At ambient temperatures above 27°C, a fibrinolytic factor is produced by *Y. pestis* that breaks down the clot, virtually eliminating the flea's capacity to transmit plague. Thus, urban plague generally occurs at higher elevations or during cooler seasons. Temperatures do not affect the transmission of sylvatic plague, therefore, sylvatic plague may occur at any time of the year.

3. Vector Ecology Profile. The primary vector of urban plague in Peru is the Oriental rat flea, *Xenopsylla cheopis*. The human flea, *Pulex irritans*, although biologically an inefficient vector, has an insatiable feeding preference for *Rattus* spp., *Cavia porcellus* (guinea pigs), domestic animals (swine, dogs and cats), and humans, and may be abundant in towns and villages. These attributes contribute to *P. irritans* potential as a vector in urban situations. *Polygenis litargus* is also an incriminated vector of plague in Peru. Vector ecology profiles for these fleas are presented in Appendix A.5. Probable sylvatic reservoirs associated with the 1992/94 outbreak are *Sciurus stramineus* (tree squirrel) and species of *Akodon* (grass mice) and *Oryzomys* (rice rats). Fleas and their hosts are listed in Appendix B.5. In Peru, the vectorial capacity of most sylvatic fleas and the role of their mammalian hosts to serve as reservoirs of plague are poorly understood. The ecology of plague among fleas and mammals of Peru is poorly understood. See Appendix G for selected keys for identification of Peruvian fleas.

4. Vector Surveillance and Suppression. Basic surveillance requires trapping rodents, collecting the fleas on them, identifying the fleas, and calculating the average number of fleas per host (flea index). Fleas are recovered either by combing with a toothbrush or running a stream of compressed CO_2 over the pelage of the rodents. Flea indices are good indicators of plague transmission potential. Interpretation of the flea index relative to specific flea species must be established for each geographic area. Human population densities, rodent species and their population densities, and the extent of any existing epizootics are important factors in evaluating and establishing an index that has value in predicting transmission, especially for urban plague. Sylvatic plague surveillance is important for evaluating populations of small mammals (*Oryzomys*, *Oligoryzyomys*, *Sciurus*) that may interface with domestic rodents. Principles and surveillance techniques are the same as those for evaluating urban plague. Serologies of cats and dogs are accurate indicators of the presence of plague in limited domestic areas, while sera from free-roaming wild carnivores are better indicators for large areas. Personnel who work with potentially plague-infected fleas or mammals should be vaccinated and use precautions during animal handling to prevent zoonotic diseases. Flea, animal, and human tissues may be submitted to the Centers for Disease Control and Prevention, National Center for Infectious Diseases, Division of Vector-Borne Infectious Diseases, P.O. Box 2087, Foothills Campus, Fort Collins, Colorado 80522 for plague analysis. Blood samples are easily collected on Nabuto strips (paper strips), dried, and submitted to a laboratory for testing (TG-103). Pending testing, preserve fleas in 2% saline with one small drop of Tween-80 detergent/liter. Tween-80 breaks the surface tension and the fleas drown, preventing potentially infective live fleas from arriving at a testing laboratory.

Plague control is usually not feasible for sylvatic epizootics except when adjacent to urban areas in circumstances where sylvatic rodents might transmit plague from the sylvatic cycle to the urban cycle. Urban plague control requires chemical treatment of rodent runs and burrows prior to controlling the rodents with rodenticides. Failure to rid rodents of their fleas prior to rodent extermination will exacerbate the potential for plague transmission by causing plague-infected fleas to seek new hosts. Carbamates such as carbaryl are effective and relatively safe pesticides to control fleas. In Peru, *Pulex irritans* is resistant to DDT, while both *Pulex irritans* and *X. cheopis* are resistant to DDT in Ecuador (WHO, 1992).

Wear permethrin-treated BDUs with trousers tucked into boots to protect against biting fleas (TIM 36). Bivouac away from human habitations, sources of man-made rodent harborage, and agricultural grain harvest areas. Avoid indigenous populations during epidemics. Maintain levels of sanitation to deprive rodents of food, water, and shelter.

V. Militarily Important Vector-Borne Diseases with Long Incubation Periods (>15 days)

A. Leishmaniasis. Leishmaniasis, a potentially disfiguring and sometimes fatal disease, is caused by a protozoan parasite and transmitted by bites of phlebotomine sand flies. All vectors of this disease in the New World are in the genus *Lutzomyia*. The disease may take several forms, characterized as cutaneous leishmaniasis (CL), mucocutaneous leishmaniasis (MCL), or visceral leishmaniasis (VL). Incubation in humans may take as little as ten days, or more than six months. Symptoms include ulcerative skin lesions (CL), lesions in the mucosal areas of the mouth and/or nose (MCL), and internal pathological manifestations resulting in fever, lymphadenopathy, anemia, enlargement of the liver and spleen, and progressive emaciation and weakness (VL). Untreated, VL usually results in death. *Leishmania peruviana* and species of the *L. braziliensis* complex have been reported in Peru. Although the clinical manifestations are not necessarily indicative of the particular strain/species of parasite, *L. braziliensis* is prone to cause the severe disfiguring MCL or "espundia." For diagnostic purposes, entomological or tissue specimens can be submitted to: Instituto de Medicina Tropical Alexander von Humboldt, Universidad Peruana Cayetano Heredia, Apartado 5045, Avenida Honorio Delgado 932, Lima 100, Peru.

1. Military Impact and Historical Perspective. Two thousand eight hundred cases of cutaneous leishmaniasis were reported in Peru in 1985. Two thousand cases were the cutaneous form called "uta". Uta is endemic at high elevations in the west-facing valleys of the Andes, primarily north of 13°S latitude, and in the inter-Andean valleys from Piura Department in the north to Lima and Junin Departments in the south. Essentially, uta is confined to elevations between 1,000-3,000 m, and most cases coincide with peak populations of *Lutzomyia peruensis* and *Lutzomyia verrucarum* (April/May) at elevations above 2,200 m. Cases of espundia have been recorded from northern Peru and the eastern slopes of the Andes to the Amazon Basin. The potential for many cases of leishmaniasis (CL and MCL) is great in the mountain valley regions, in the northern half of Peru, and east of the Andes. Although not immediately incapacitating, leishmaniasis would be detrimental for units and individuals in terms of time lost due to treatment and follow-up. Development of the simplest form of the disease (CL) would typically require a three-week course of treatment and hospitalization. Isolates of *L. braziliensis* resistant to standard antimony treatment have been documented. Scarring that accompanies the cutaneous form of the disease can also contribute to poor unit morale. Units of American soldiers undergoing jungle training in Panama have experienced attack rates as high as 32%. Soldiers on night patrols that require constant starting and stopping, sitting in place for periods of time, and proceeding through multiple habitats are extremely vulnerable to biting sand flies. Keeping as much of the skin covered as possible and using extended-duration deet repellents are crucial preventive measures.

2. Transmission Cycle. New World leishmaniases are zoonoses. Humans become infected incidentally when they enter the habitat of the vector and reservoir. When a sand fly feeds on an infected host, ingested parasites develop and proliferate within the fly as motile promastigotes. The flies become infective 8-20 days after an infected blood meal. At subsequent feedings, the motile promastigotes are injected into the bite, are sequestered by macrophages, and become non-motile amastigotes. The amatigotes multiply, eventually rupturing the macrophages, and dispersing to infect other macrophages. Hosts may remain infective to sand flies for a few months to several years. Domestic dogs and opossums (*Didelphis albiventris*) are suspected domestic/peridomestic reservoirs of *L. peruviana*. As many as 50% of the dogs in endemic foci are infected. *Phyllotis andinum* (leaf–eared mouse) is a suspected sylvatic reservoir of *L. peruviana*, and others may be involved. Reservoirs in some localities remain unknown. As the list of potential sand fly vectors continues to grow, new species of *Leishmania* are also being discovered. Currently, 14 species of *Leishmania* have been identified in the Americas. At least four species, *Leishmania* (*Viannia*) *brasiliensis*, *L.* (*V.*) *guyanensis*, *L.* (*V.*) *peruviana* and *L.* (*Leishmania*) *amazonensis*, have been documented in Peru.

3. Vector Ecology Profile. Some man-biting sand fly species do not transmit *Leishmania* parasites. Important proven vectors in Peru identified by the WHO Expert Committee on Control of Leishmaniasis (1990) include *Lutzomyia* (*Helcocyrtomyia*) *ayacuchensis*, *Lu.* (*H.*) *peruensis* and *Lu. verrucarum*. In addition, Killick-Kendrick (1990) lists the Peruvian species *Lu.* (*Nyssomyia*) *flaviscutellata*, *Lu.* (*N.*) *umbratilis* and *Lu.* (*Psychodopygus*) *c. carrerai* as proven vectors of leishmaniasis. Vector ecology profiles for species with available data are presented in Appendix A.6. Sand fly species known to harbor various species of *Leishmania* parasites are annotated in the list of Peruvian *Lutzomyia* species, Appendix B.2.

4. Vector Surveillance and Suppression. Sand flies can be collected with mechanical or mouth aspirators from interior or exterior walls of dwellings, tree trunks, rock crevices, animal shelters, etc. Collecting from human bait has the advantage of capturing anthropophilic species, but is a risky practice in endemic areas. Human-bait collections should be conducted under an approved human-use protocol. Sticky paper traps made from bond paper soaked in castor oil can be placed in burrows, rock hollows and other places frequented by sand flies. The flies stick to the oil and can easily be removed, counted, identified, and tested or examined for parasites. Some species of sand flies are readily attracted to light traps and can be successfully trapped in standard CDC light traps with fine mesh collecting bags. Various types of animal-baited traps can also be employed (Disney and Shannon Traps). When establishing semi-permanent or permanent bivouac sites, clear areas to provide a vegetation-free buffer zone of about 50 m between encampments and forested areas. Apply residual pesticides to perimeter vegetation. Since sand flies are weak flyers, these measures will provide an effective barrier between potential sand fly vectors and humans. Apply residual pesticides to walls of buildings or to tents (interior and exterior), particularly in bivouac bedding areas (TIM 36). Implement ULV spray operations during the peak-biting period (dusk and dawn) for quick knockdown of flying sand flies (TIM 24). Wear BDUs with trousers bloused and sleeves rolled down just prior to sunset and after dark, apply extended-duration deet repellents on exposed skin, and use fine mesh bednets when possible (TIM 36).

B. Bartonellosis. Bartonellosis (Carrion's disease) is caused by *Bartonella bacilliformis* and has two clinical manifestations: Oroya fever and verruga peruana (verruga warts). Sand flies of the genus *Lutzomyia* are suspected vectors of the bacterium. The symptoms of Oroya fever are fever, headache, myalgia, arthralgia and severe hemolytic anemia that often results in death if untreated. Verruga peruana is a chronic form of the disease marked by nodular lesions that vary in degree of development. It may be preceded by Oroya fever by weeks to months, although verruga peruana may also occur without any symptoms of febrile illness. Recent reports indicate that in Peru verruga peruana occurs frequently on the feet and hands of persons residing near sea level, and on the elbows and knees of persons living above 1,800 m. Symptoms usually occur 16-22 days following the bite of an infected sand fly, although they may not materialize for 3-4 months. Humans are the only known reservoir of *B. bacilliformis*, which may circulate in the blood for weeks prior to the appearance of clinical symptoms and for years thereafter. The bacteria may be transmitted during blood transfusions.

1. Military Impact and Historical Perspective. Outbreaks have occurred at Matucana (1,850 m/6,068 ft) and along the Rio Rimac, Lima Department, and in La Oroya, Junin Department. In 1987, 28 cases of Oroya fever (with 14 deaths) occurred in the village of Shumpillan located on an east-facing slope (2,755 m), near the Rio Maranon in Parobamba District, Pomabamba Province, Ancash Department. An outbreak occurred from February to April, 1998, in the provinces of Urubamba, Calca and Urcos, Cusco Department (c.a. 3200 m/10,500 ft), with a reported 145 clinically diagnosed cases (38 deaths) and 103 laboratory confirmed cases (10 deaths). This is the first time bartonellosis has been reported from this region, and is the southernmost report of bartonellosis in South America. A case of verruga peruana was identified from this area in June, 1998. The first American troops with no immunity to this disease might well experience a repeat of the Peruvian outbreak of 1885 that resulted in hundreds of deaths among Chinese brought to Peru to build the railroad. The outbreak was most severe in the area where the railroad crosses the Rio Rimac at the Verrugas Bridge (Junin Department). In addition, all members of a cavalry unit traveling to the area with a consignment of silver reportedly died. Although readily treatable today, many cases of bartonellosis could occur rapidly at endemic sites. Cases outside the endemic foci would probably be sporadic and isolated.

2. Transmission Cycle. Little is known about the epidemiology and transmission of bartonellosis. Humans are the only known reservoir. The role of animal reservoirs (if any) is unknown, although *Bartonella bacilliformis* was isolated from a species of leaf-eared mouse (*Phyllotis*) in Peru in 1948. Domestic guinea pigs (*Cavia porcellus*) and chickens were also implicated as reservoirs at a disease focus in Ecuador. *Lutzomyia* sand flies are suspected vectors, but transmission patterns are not well understood.

3. Vector Ecology Profile. Although never proven, *Lutzomyia verrucarum* and *Lutzomyia* (*Helcocyrtomyia*) *peruensis* are suspected vectors of bartonellosis in Peru. Vector ecology profiles for these two species are in Appendix A.6. Oroya fever usually occurs between elevations of 600-2,450 m.

4. Vector Surveillance and Suppression. See leishmaniasis, paragraph V.A.4., for surveillance and suppression of sand flies. Since little is known about the vector species responsible for transmitting bartonellosis, all species of sand flies should be controlled. Blood supplies should be screened for *B. bacilliformis* in endemic areas.

C. Mansonellosis. Mansonellosis is infection with the filarial worms *Mansonella ozzardi* or *M. perstans*, transmitted by bites of black flies (*Simulium* spp.) or biting midges (*Culicoides* spp.). Most infected people are completely asymptomatic, but some suffer joint pains, headaches, poor circulation in the lower extremities, inguinal lymphadenopathy, and pruritic red spots. Microfilariae may also enter the eye, causing eye infections.

1. Military Impact and Historical Perspective. Mansonellosis is endemic in the eastern departments of Guainia (*M. ozzardi* and *M. perstans*), Vaupes, Amazonas, Antioquia and Choco (*M. ozzardi*) of neighboring Colombia. Although data are not available for Peru, Loreto Department must be considered potentially endemic for *Mansonella* along all tributaries feeding into the Amazon. Human cases of mansonellosis would negligibly impact military operations, but a few infected individuals may require treatment after departing the theater of operations.

2. Transmission Cycle. Both species of *Mansonella* have similar developmental cycles. Microfilariae are ingested from a human host during blood feeding by species of *Simulium* or *Culicoides*. The microfilariae migrate from the midgut to the thoracic muscles, where they develop to second-stage larvae. By the 6^{th} (*Simulium*) or $9\text{-}11^{th}$ (*Culicoides*) day post-feeding, mature third-stage larvae are present in the head capsule. During feeding, mature larvae crawl out of the proboscis and enter the bite wound. Males and females migrate to the peritoneal cavity, mate and produce microfilariae. The microfilariae are non-periodic and may be found in the blood and skin at all times.

3. Vector Ecology Profile. Little is known about the vectors of *Mansonella*, but at least four species of the *Simulium amazonicum* group in neighboring Colombia have been shown to support development of *M. ozzardi* to the infective stage. *Simulium argentiscutum*, an anthropophilic species, has also been incriminated as a vector. In addition, *Culicoides insinuatus*, *C. furens*, *C. paraensis*, and *C. caprilesi* are known to harbor infective stages of *M. ozzardi*, although *Culicoides caprilesi* is probably unimportant in transmission because of low infection rates.

4. Vector Surveillance and Suppression. Surveillance of black flies should be performed during the aquatic stages, when control techniques are feasible. Visual inspection of streams/rivers and sampling of larvae from all areas of a body of water (rocks, submerged vegetation and debris, etc.) will provide information on species composition, stage of development, and population dynamics. Survey data will provide information for timely and specific control strategies. The best time to control black fly populations is during the larval stages (before pupation). Formulations of *Bacillus thuringiensis israelensis* are economical, operationally feasible, and effective in controlling black fly larvae in main river systems. Chemical control measures are largely ineffective for controlling adult black flies. Anthropophilic species of *Culicoides* can be collected with mouth aspirators on human bait.

Daily biting activity is species dependent. Some species are easily trapped with standard CDC light traps equipped with fine mesh bags or DDVP killing-jars. Avoid open sunlit areas along streams, wear permethrin-treated BDUs with sleeves rolled down, and use extended-duration deet repellent on exposed skin surfaces (TIM 36).

VI. Other Diseases of Potential Military Significance

A. Hantavirus Pulmonary Syndrome (HPS). Human hantaviral disease in South America is an emerging zoonotic phenomenon that is not well understood. Hantavirus is transmitted to humans by inhalation of virus-contaminated dust particles, ingestion of virus-contaminated rodent excreta, or potentially through the bite of an infected rodent. Symptoms of hantavirus include fever, headache, abdominal, joint and lower back pain, and sometimes nausea and vomiting, progressing rapidly to acute respiratory distress (HPS). The usual incubation period is about 14 days, but it ranges from three days to six weeks. Death occurs in ca. 50% of cases. HPS was first identified during an epidemic in Argentina (1992-96). Additional outbreaks have occurred in the Four Corners area of the southwestern U.S. (1993), Brazil (1993), Paraguay (1996) and Chile (1997). Two isolates of hantavirus were reported in late 1996 from the rice rat, *Oligoryzomys microtis*, in neighboring Bolivia. Recently (September 1997), an unconfirmed human case of hantavirus was reported in the vicinity of the port cities of Matarani and Mollendo, Peru. Among South American rodents, hantavirus has been reported in the rice rat, *Oligoryzomys flavescens*, long-tailed pygmy rice rat, *Oligoryzomys longicaudatus*, grass field mouse, *Akodon azarae*, and dark field mouse, *Bolomys obscurus* from Argentina (Andes virus), and from the vesper mouse, *Calomys laucha*, in Paraquay (Leguna Negra virus). All South American mammalian reservoirs associated with hantavirus belong to the murid subfamily Sigmodontinae. *Oligoryzomys microtis* occurs in the eastern lowlands of Peru and Bolivia. The risk of cases occurring during military operations is remote, but civil actions in Vietnam frequently required soldiers to handle (move) large quantities of rice. Such operations associated with grain crops (wheat, barley, corn, and rice, noted in the Mollendo area of Peru) might expose soldiers to hantavirus, if the grains are contaminated by reservoir rodents. Maintain a high level of sanitation to deprive rodents of food, water, and harborage.

B. Rabies. Rabies is a zoonotic viral disease transmitted in the saliva of mammals. It is almost invariably fatal to humans. Cats, dogs and bats are the principal reservoirs. Rabies is frequently epizootic among bats, wild canines and other carnivorous mammals. A serious outbreak of bat rabies (8 human deaths) occurred in May/June 1997 adjacent to Amazonas Department in the neighboring Ecuadorian villages of Kunkuki, Numbatkaime, and Warinta, in the Cordillera del Condor, Zamora-Chinchipe Province. Vampire bats (*Desmodus rotundus*), which will feed on sleeping humans, were responsible for the infections. Troops occupying the northern lowlands along the Rio Maranon should be taught about the dangers posed by vampire bats. Soldiers should sleep under bednets when possible and avoid contact with local dogs and cats. Immediate reporting for medical treatment is paramount when bites occur or are suspected to have occurred. Units should not adopt animals as mascots.

VII. Noxious/Venomous Animals and Plants of Military Significance

A. Arthropods. Identification keys for medically important arthropods are cited in Appendix G. Insect/arachnid bites and stings may cause allergic reactions, create secondary infections and lower unit morale, not to mention their potential disease implications. U.S. Army trip reports filed by medical personnel (1997) indicate that insect bites and accompanying syndromes were a major complaint among soldiers and medical personnel in the Bolivian Army operating in lowland areas east of the Andes. The lowland topography and climate of Peru are somewhat comparable. Mosquitoes, major biting pests in tropical and semi-tropical regions, have been discussed above. Consult Appendix B.1. for mosquitoes that occur in Peru. The following groups of arthropods include most of the major pests. Residual insecticides (chlorpyrifos, diazinon) applied to grounds and vegetation prior to encampment will eliminate many arthropod pests. Treat tentage periodically with permethrin and use d-phenothrin or other suitable aerosols within enclosed spaces (TIM 24). Avoid using pallets for tent flooring because these provide harborage for unwanted pests. Use of extended-duration deet repellent on the skin and impregnation of the clothing with permethrin combined with proper wearing of the BDU will provide the individual soldier with nearly complete protection from most arthropods (TIM 36). Africanized honeybees, wasps, spiders, centipedes, scorpions, and other stinging/biting arthropods require additional precautions, as noted below. When retiring, roll clothing tightly and stretch socks over boot tops to exclude entry of crawling arthropods. Shake clothing and boots briskly before dressing and inspect for unwanted intruders. Foxholes are ideal pit traps for crawling arthropods (scorpions, centipedes, spiders, etc.), and snakes may also fall into them. Dug-in troops should always check foxholes for potentially dangerous animals. Following are the major groups of arthropod pests.

1. Ceratopogonidae (biting midges, no-see-ums, punkies). Some anthropophilic species of Ceratopogonidae (*Culicoides*, *Leptoconops*) are extremely annoying. Their bites may produce systemic allergic reactions as well as local irritation. Because of their small size, they may go unnoticed until an individual receives many bites. Breeding habits differ from species to species. Some are tree hole breeders, some breed in moist decaying vegetable material, while others are associated with the edges of streams, swamps, ponds and lakes, where adults lay eggs at the interface of moist soil and water. Development may occur in the water, wet soil, or in wet decomposing vegetation (see *Culicoides paraensis*, Appendix A.3.). Massive emergence of adults may occur in some species.

2. Dipterans Causing Myiasis. The human bot fly (family Cuterebridae) and the primary screwworm (family Calliphoridae) are major causes of myiasis in humans throughout South America. The human bot fly (*Dermatobia hominis*), less than one centimeter in length, lays its eggs on other arthropods (usually diurnal blood-feeding dipterans, e.g., mosquitoes, deer flies, etc.). While the arthropod carrier feeds on a human host, the phoretic larva emerges onto the host's skin, penetrates, and begins to develop. The larva remains at the site of entry throughout its 3-4 month development, causing an irritating form of cutaneous myiasis. The primary screwworm (*Cochliomyia hominivorax*) deposits numerous eggs in a few minutes on any area of broken skin (even sites as minor as a scratch or the site of a tick bite may be attractive). The eggs hatch in <24 hours and the larvae penetrate, feeding on live tissues. They feed for 3-6 days before pupating, causing significant pain and tissue damage. Females also may lay eggs in the nasal passages of sleeping humans. The larvae may invade the nasal cavities, sinuses, and eustachian tubes, causing severe damage. Human deaths have been reported from nasal infestations of the primary screwworm. Fortunately, screwworm flies do not fly after dark. Use extended-duration deet repellent on all exposed skin surfaces to prevent mosquitoes and other biting arthropods from gaining the contact required for *D. hominis* invasion. To prevent potential infestations of *C. hominivorax*, avoid sleeping during the day without headnets or bednets, and keep all cuts, scratches and open sores covered.

3. Lepidoptera (urticating moths/caterpillars). Numerous species of tropical lepidoptera have urticating hairs or setae that may cause serious dermatitis. Outbreaks of urticarial reactions have occurred periodically among military personnel in Panama. Investigations revealed that urticarial hairs of caterpillars had dropped into the local swimming pools, causing skin irritations on swimmers. Avoid contact with caterpillars regardless of how harmless they might appear. Acute episodes of urticarial dermatitis caused by nocturnal moths of the genus *Hylesia* (Saturniidae) are frequently observed in some regions of Peru below 2,800 m (9,184 ft). Dermatitis is caused by poisonous abdominal setae of the female moths. Except indirectly, humans seldom come in contact with these moths. Swarms of moths often invade villages at sunset and fly throughout the night around street or porch lights. The insects lose millions of setae that are carried by air currents and ultimately are inhaled or land on the skin of unsuspecting people. Large outbreaks have been reported along the Huallaga River, San Martin Department, at the base of the eastern Andes. The moths emerge twice a year in April/May and in December/ January. Every 4-5 years an emergence of immense proportions occurs, creating many cases of urticarial dermatitis. Clinically, lesions appear as an urticarial rash, especially on the neck and forearms. The rash remains for approximately a week. Lesions are aggravated by repeated nightly exposure to setae. Itching or rubbing the rash spreads the setae and exacerbates the condition. Newly exposed personnel are more vulnerable to an adverse reaction than previously “immunized” individuals. Oral antihistimines and steroids, and topical application of natrium hyposulphite have proven useful.

4. Meloidae (blister beetles). Blister beetles produce cantharidin, a powerful vesicant that can cause blistering when in contact with exposed skin. Blister beetles are attracted to lights around sentry guard posts and frequently drop down soldiers’ necks or onto their bare arms causing blisters. Such incidents are frequent among soldiers standing guard under streetlights in Panama. Similar encounters with blister beetles could occur in Peru. Blisters usually result from rubbing or crushing the insects on the skin. Similar phototrophic behavior and blistering occurs in some species of beetles of the family Staphylinidae.

5. Simuliidae (black flies). Temperate Andean regions are not inhabited by anthropophilic species of black flies, although rivers and streams flowing out of the Andean foothills (toward the coast and toward the eastern lowlands) do produce black fly species that annoy humans. All anthropophilic black fly species in South America belong to the genus *Simulium*. *Simulium metallicum* is an important human-biter in Peru. Species of *Simulium* reported to occur in Peru are listed in Appendix B.6.

6. Siphonaptera (fleas). Fleas can be an immense source of discomfort. Sensitivity to flea bites may vary from person to person. The most annoying fleas that commonly occur in Peru are *Pulex simulans*, *P. irritans* (human flea), *Ctenocephalides canis* (dog flea), *Ctenocephalides felis* (cat flea), *Xenopsylla cheopis* (Oriental rat flea) and *Tunga penetrans* (sand flea, chigoe, jigger). The identification of *Pulex simulans* and *P. irritans* are frequently confused. *Xenopsylla cheopis*, the premier vector of plague, normally does not leave its rodent hosts (*Rattus* spp.) in the domestic setting unless the rodents are exterminated without first chemically controlling the fleas. Fleas leaving dead hosts are quite mobile, jumping as much as 12 inches, and readily bite humans. *Xenopsylla cheopis* is most common where humidity is high. Dog and cat fleas are usually found in and about homes where animals are free to roam. Eggs are laid on the host and drop to the floor/ground, hatch and undergo three larval stages. When a dwelling is abandoned, the flea larvae will ultimately pupate and remain in a quiescent state for long periods of time. The vibrations caused by someone entering such premises will stimulate a mass emergence of hungry adult fleas. Avoid using abandoned dwellings. *Pulex irritans*, although called the human flea, is a parasite of free-roaming domestic swine and is indiscriminate in its choice of hosts. This flea bites voraciously indoors and outdoors and is especially prevalent in domestic settings in higher Andean valleys. Although not encountered often, *T. penetrans* may infest primitive peridomestic settings. This flea's ability to penetrate skin and remain embedded can cause extreme discomfort. It is sometimes associated with llamas and vicunas in southern Peru and dogs and swine throughout the country. Blousing trousers inside boots is essential in providing a barrier. Fleas will crawl under blousing garters.

7. Tabanidae (deer/horse flies). Biting fly species of the genera *Chrysops*, *Haematopota* and *Lepiselaga* are important pests of man. Species of *Tabanus* are primarily zoophilic, but some may also bite humans. Deer and horse flies breed along rivers, lakes, swamps and other aquatic habitats. Although they are capable of extended flight, they usually remain close to their breeding grounds. Human exposure is greatest close to sources of water and in low-lying areas. The flies inflict painful bites, and some species will bite through tight-fitting clothing such as t-shirts. Anthropophilic species are strictly diurnal and feed in open or forested areas, depending on the species. Skin repellents are deterrents but do not provide complete protection from biting tabanids. Avoid operating in wet swampy areas and other aquatic habitats when possible, and keep sleeves down when tabanids are active.

8. Chiggers and Ticks. Chiggers are parasitic larvae of the mite families Trombiculidae and Leuwenhoekiidae. Nymphal and adult stages are non-parasitic. Primary man-biting species include *Eutrombicula alfreddugesi*, *E. batatas*, and *E. tropica*. Other species of *Eutrombicula* may also be a nuisance but the systematics of the genus is currently not well established in the region. Species of *Neotrombicula* may occasionally be involved in human infestations. Usual hosts for species affecting man are rodents, birds and reptiles, man being an accidental dead-end host. Chiggers do not burrow into the skin, or take a blood meal, but feed on liquefied tissue. Attached chiggers secrete powerful enzymes that disintegrate host skin cells. Eventually, the host tissue-response forms a feeding tube (stylostome) from which the mite imbibes liquified tissue. Intense itching is caused by the formation of the stylostome. Unlike chiggers, six-legged larval (seed) ticks and eight-legged nymphs of the family Ixodidae (hard ticks) each require a blood meal to molt to the next stage. Ticks penetrate the host's skin with their mouthparts and remain attached for various periods, depending on the species. Refer to Appendix H for proper tick removal procedures. Although different species have different host preferences, mammals (small and large) or birds are the most common hosts. Individuals react differently to bites of these two groups of ectoparasites. The intense itching that often accompanies chigger and tick bites may lead to excoriated lesions subject to secondary infections. Their bites can become a serious morale problem for individuals, particularly those who are sensitized. The host-seeking behavior of chiggers and ticks is similar. The larvae of both families display a clustering behavior where hundreds will congregate on an object (leaf, twig, etc.) in a host-questing posture. Potential hosts (man included) may brush against the cluster, becoming infested with hundreds of chiggers or larval seed ticks. Either may quest on vegetation up to several feet in height, but chiggers tend to remain closer to the ground (boot-top height or less). These behaviors account for the spotty distribution of infestations, in which some people get badly bitten, while others receive only a few bites or none. Initially, chigger infestations usually begin at ankle level. Chiggers have a propensity for attaching to humans under tight-fitting clothing (e.g., boot tops, belt line, bra lines) and areas of thin skin (e.g., behind knees, groin, peritoneal and axillary regions), while ticks are less selective, but prefer hairlines. Species of Peruvian ticks and their hosts are listed in Appendix B.4. To prevent infestation, use extended-duration deet repellent on exposed skin and ensure that BDUs are impregnated with permethrin (TIM 36). Ticks and chiggers will crawl under trouser blousings, avoiding both the clothing and repellent barriers of the BDU. It is essential to tuck trousers inside boot tops to maximize the protective barrier.

9. Scorpions. Species of scorpions that occur in Peru are listed in Appendix B.7. Most South American scorpions are considered no more toxic than common bees and wasps, although some people may be hypersensitive and suffer significant reactions. Scorpions are most active at night and may crawl into clothing and bedding. See precautions in paragraph VII.A.9. above.

10. Spiders. Brown recluse spiders (*Loxosceles laeta*, and *L. rufescens*), black widow spiders (*Latrodectus* spp.), and banana spiders (*Phoneutria boliviensis* and *P. fera*) are common poisonous spiders that occur in Peru. Banana spiders present the greatest potential for serious spider bites among troops sleeping on the ground. The nocturnal wandering habits of these solitary spiders bring them into frequent contact with people by crawling into clothing, shoes, bedding, tentage and equipment. Little has been written about *P. boliviensis* or *P. fera*, but the Brazilian species *Phoneutria nigriventer* has a reputation for being extremely aggressive and inflicting many serious bites in populated areas of eastern Brazil. *Phoneutria nigriventer* and *Phoneutria reidyi* occur in the neighboring regions of Amazonas State, Brazil, and may also occur in the northeastern lowlands of Peru. *Phoneutria* and *Latrodectus* venom is neurotoxic, while *Loxosceles* venom may cause severe necrotic lesions. Other species of spiders are capable of causing painful bites, but reactions are generally restricted to local pain, itching, and swelling. Prevent spider bites by following the guidelines in paragraph VII.A. above.

11. Centipedes. Centipedes in tropical countries attain considerable size and are capable of inflicting painful bites that cause swelling and local tenderness, but they are not considered dangerous. Their toxicity is comparable to that of a bee sting, although the acute pain is much greater and there is more tissue trauma at the sight of the bite. The width of fang punctures may exceed ¾ of an inch.

12. Bees, Wasps and Hornets. The most significant threat among the Hymenoptera is the Africanized honey bee (AHB), endemic throughout Peru. Several behavioral features of AHB make them especially dangerous to military personnel: 1) they are extremely aggressive and defensive of their hive, 2) they swarm and abscond excessively, and 3) they frequently build hives close to the ground in any protected cavity. Operations in wooded areas increase the risk of troops interacting with swarming AHB or their hives, particularly at night when they cannot be seen. If encounters occur, move away as swiftly as possible. Bees are not as aggressive away from the hive and have no method of homing in on an intruder at night. Avoid hives and swarming colonies of honey bees (TIM 34). Wasps and hornets are ever present in most localities and isolated stings can be expected. Bee sting kits should be available for individuals with known hypersensitivity to bee stings.

B. Snakes. The venomous terrestrial snakes of northwestern South America belong to the families Elapidae and Viperidae. Coral snakes, cobras, kraits, mambas, and sea snakes constitute the Elapidae but, of the terrestrial members, only coral snakes (*Leptomicrurus* spp. and *Micrurus* spp.) occur in the Neotropical Region. Although extremely toxic, coral snakes' timid and reclusive habits preclude them from being encountered often. Coral snakes will not bite unless handled or provoked, and their fangs are short, requiring a chewing action that delivers only small quantities of venom. Although they pose little threat, their infrequent bite victims suffer 50% fatalities. The family Viperidae contains six venomous genera (*Bothriechis, Bothriopsis, Bothrops, Crotalus, Lachesis,* and *Porthidium*) in northwestern South America. These snakes are frequently encountered and their bites may be life threatening. Arboreal or semi-arboreal genera include *Bothriechis* and most species of *Bothriopsi*s and *Bothrops*. Arboreal species are especially dangerous because their fangs are very long, they deliver copious amounts of venom, and victims are likely to be bitten on the head, arms and upper trunk areas. *Crotalus, Lachesis,* and *Porthidium* spp. are primarily ground dwellers. During floods, many of the ground-dwelling snakes (poisonous and nonpoisonous) migrate to the high water line, increasing the risk of bites. Venoms of viperids vary in toxicity from species to species. Most snakebite deaths in Peru are caused by *Bothrops* spp., to which the fer de lance (*B. asper*) and barba amarilla (*B. atrox*) belong. Other extremely dangerous snakes include the bushmaster (*Lachesis muta* spp., rarely encountered because of its preference for nocturnal activity) and the tropical rattlesnake (*Crotalus durissus* spp.), reputedly the most dangerous snake in the Americas. Venomous snakes known to occur in Peru are listed in Appendix C, together with distributional data. Currently recognized species follow the systematic scheme of K.R.G. Welch (1994). J. Coborn's The Atlas of Snakes of the World (1991) is an excellent colored pictorial reference for many of the species that may be encountered. Sources of snakebite antivenoms are provided in Appendix D.

C. Plants. Plants that cause contact dermatitis are listed in Appendix E, and those that produce systemic toxic symptoms (and even death) when ingested are listed in Apprendix F. The components of each plant species (leaves, seeds, etc.) and chemicals that are thought to cause skin reactions or systemic poisoning are listed next to each species. Plants most important to military personnel are *Toxicodendron* spp. and *Anacardium occidentale* (cashew nut). Peruvian species of *Toxicodendron* (itil, incati and maico) are similar to U.S. species (poison ivy and poison oak) and cause comparable skin reactions that are exacerbated in the tropical climate. Soldiers are frequently placed "on quarters" or even hospitalized at some

CONUS installations. The cashew nut is extremely toxic if eaten uncooked, and the resin in the plant and fruit can cause extensive skin damage. Troops should be taught to recognize and avoid these plants.

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Appendix A.1. Vector Ecology Profile: Vectors of Malaria in Peru.

VECTOR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Anopheles darlingi	Little known about Peruvian distribution, but is the primary vector of *P. falciparum* in the Amazon Basin of Peru.	Most abundant during rainy season. Populations decrease during the dry season.	Associated with floating or emergent vegetation along river and stream margins with algae. Less often associated with ponds and swamps. Partial shade. Areas of secondary growth. Water temperatures may vary from 17-33 C. Requires pH near 7.0. Often water has tannin and is not clear.	Exophagic[1] and endophagic[2]. Bimodal biting activity begins at dusk, with peak ca. 2000-2200 hours. Biting activity subsequently declines with an increase just before sunrise.	Endophilic[3]. Rests on walls 10 minutes before biting. After feeding, usually rests on vertical surfaces within 2 m of floor, on ceilings, or on vegetation outdoors.	Usual: 200-1,500 m. Maximum: 4.8 km.
Anopheles pseudopunctipennis	Found in high warm Andean valleys throughout country.	Dominant during 3-4 months of dry season (May/June-August).	Pools in streams and rivers that are drying up following the end of the rainy season that occurs in April/May. *Spirogira* required for larval development. Water temperatures between 18-20 ℃, pH. 7.5-8.5.	More anthropophilic than zoophilic. Exophagous or endophagous. Dusk and dawn.	Prefers upper rafter areas indoors. Negatively phototrophic.	Females: 3-6 km. Males: 400-500 m.
Anopheles nuneztovari	Limited numbers in eastern part of Junin Department. Primary vector in some areas when encountered in greater abundance.	Most abundant during rainy season, particularly where *An. darlingi* is absent.	Open marshy areas, along grassy margins of ponds and lakes. Full sunshine or partial shade. Aquatic vegetation and algae often abundant.	Endophagous and exophagous. Rests on walls after taking a blood meal. Biting activity begins at dusk, with peak ca. 2000-2200 hours.	Exophilic[4] first 2 hours after dark, but enters dwellings thereafter. Rests on walls 1 m or less from floor.	Unknown.
Anopheles calderoni	Coastal lowlands below 250 m (Departments of Piura, Lima and Ica).	Unknown.	Small streams, irrigation canals, swamps associated with dense emergent vegetation, especially cattails (*Typhas* sp.). Prefers water temperatures of around 26 ℃.	Anthropophilic.	Unknown.	Unknown.
Anopheles trinkae	Primary vector along foothills of eastern slopes of Andes, transitioning to lowlands of Amazon basin.	Dominant during 8-9 months of the rainy season (September –April/May).	Transitional temporary pools.	Anthropophilic.	Unknown.	Unknown.
Anopheles mediopuctatus	Forested areas of Amazon Basin. Principal vector of monkey malaria (*P. brazilianur*) in humans.	Unknown.	Unknown.	Anthropophilic and exophagic.	Unknown.	Unknown, but restricted to forested areas.

[1]Exophagic – bites outdoors. [2]Endophagic – bites indoors. [3]Endophilic – rests indoors. [4]Exophilic – rests outdoors.

Appendix A.2. Vector Ecology Profile: Vectors of Dengue and Yellow Fever in Peru.

VECTOR	VIRUS	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	BREEDING HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Aedes aegypti (*Aedes albopictus*)[1]	Dengue, Urban Yellow Fever	Urban, suburban, and rural communities at lower elevations in the Departments of Tumbes, Piura, Lambayeque, Madre de Dios and Loreto.	Conditions are optimal year-round in wet lowlands of the Department of Loreto. In other regions, populations increase at the onset of the rainy season (December/January) when artificial containers are filled and vectors are prone to congregate more indoors.	Almost exclusively in artificial containers associated with man, i.e., discarded tires, flower pots, vases, rain gutters, rain barrels, cisterns, etc. Occasionally develop in leaf axils such as *Agave* spp. and banana palms. Females lay single eggs, larvae develop in 9 days (4-7 under ideal temperatures), pupae in 1-5 days.	Agressively anthropophilic. Equally exophagic and endophagic. Biting occurs throughout daylight hours.	Endophilic and exophilic. Rests during the hours of darkness.	Usually less than 200 m. Maximum: ca. 2 km., especially when breeding areas are scarce.
Haemagogus janthinomys	Sylvatic Yellow Fever	Mountain rain forests in departments of Haunuco, Pasco, Ayachuco, Junin, San Martin and the tropical rain forests on the eastern slopes of the Andes in the departments of Madre de Dios and Loreto.	Present year round, but population peak during the wettest season (January-March) and decline during dryer spells (April-December).	Breeds in tree holes and bamboo stumps. The gonotrophic cycle lasts about 10 days and females may live as long as 95 days (average ca. 2 weeks). Over 75% of the eggs are laid between 1200-1600 hours with no eggs laid at night. Most eggs are laid during rainy periods.	Little biting activity outside 1200-1400 hours. Will leave canopy to bite at ground level, especially in damaged forest and along forest edges. Bites during daytime, primarily between 1200-1400 hours, in forests.	Canopy mosquito.	Unknown, but thought to be very limited.

[1] The vector ecology profile for *Ae. albopictus* differs little from that of *Ae. aegypti*. Although *Ae. albopictus* does not presently occur in Peru, it can be expected to spread from western Brazil into Peru.

Appendix A.3. Vector Ecology Profile: Vectors of Arboviruses Other Than Dengue or Yellow Fever in the Amazon Basin and Associated Northwestern Regions of South America.

The geographic distribution of vectors is given in broad terms and a vector may occur in only part of the country mentioned. Furthermore, the distribution given does not imply that any species is a vector over the whole of its range. Country names in parentheses after the arbovirus name indicate that the virus was isolated in that country from the vector listed in the same row of the table. "Geographic Distribution" indicates the countries in which the vector has been found, but does not necessarily indicate the distribution of the arbovirus.

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Aedes arborealis	Apeu (Brazil)	Marsupials (*Caluromys philander).*	Brazil, French Guiana, and Suriname.	During rainy season (November to March) in tropical rain forests.	Treeholes.	Known to bite humans.	Unknown.	Unknown.
Aedes hastatus	Western Equine Encephalitis (WEE) (Ecuador)	Epizootic transmission undefined, but passerine birds considered important reservoirs.	Argentina, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Honduras, Mexico, Panama, and Peru.	Unknown.	Temporary ground pools.	Bites humans by day in the forest.	Unknown.	Unknown.
Aedes scapularis	Venezuelan Equine Encephalitis (VEE) (Ecuador, Peru)	VEE: Many mammals and birds, but equines are key reservoirs with high viremias.	Argentina, Bolivia, Colombia, Cuba, Dominican Republic, Ecuador, French Guiana, Guyana, Haiti, Jamaica, Mexico, Panama, Paraguay, Peru, Puerto Rico, Suriname, Trinidad, United States, and Venezuela.	VEE virus activity begins at the end of the rainy season and disappears when the dry season is underway.	Temporary ground pools.	Feeds on birds and large mammals but prefers mammals. A vicious biter of humans, it feeds night or day in a wide variety of locations. It commonly moves indoors in areas that have been populated for long periods.	Unknown.	In one study, observed to move at least 4 km in 11 days.
Aedes septemstriatus	Apeu (Brazil)	Marsupials (*Caluromys philander).*	Brazil, Colombia, Costa Rica, Nicaragua, and Panama.	During the rainy season (November to March) in tropical rain forests.	Treeholes and broken bamboo.	Bites humans by day in the forest.	Unknown.	Unknown.
Aedes serratus	Oropouche	Primates (*Cebus, Alouatta, Saimiri, Saguinus*), sloths.	Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guadaloupe, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Peru, Puerto Rico, Suriname, Trinidad, and Venezuela.	Epidemics occur during the rainy season (November to March).	Temporary ground pools.	Bites humans by day in the forest, but prefers to bite at night in open areas. Prefers ground level and often enters buildings. Will also feed on chickens.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Aedes taeniorhynchus	Oriboca VEE (Ecuador, Peru)	Oriboca: *Oryzomys capito*, *Proechimys guyanensis*, *Didelphis marsupialis*. VEE: Many mammals and birds, but equines are key reservoirs with high viremias.	Antigua, Bahamas, Belize, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, French Guiana, Guatemala, Guyana, Haiti, Jamaica, Mexico, Nicaragua, Panama, Peru, Puerto Rico, Suriname, St. Lucia, Trinidad, United States, and Venezuela.	Oriboca transmission occurs during the rainy season in tropical rain forests (November to March). VEE virus activity begins at the end of the rainy season and disappears during the dry season.	Coastal salt marshes and mangrove swamps.	Vicious biter of humans by day and night in many kinds of habitats; most active at dawn and dusk.	Rests in vegetation, emerging to bite when disturbed.	Flies up to 32 km.
Anopheles albitarsis Group	WEE (Ecuador)	Epizootic transmission undefined, but passerine birds considered important reservoirs.	Argentina, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Panama, Paraguay, Suriname, Trinidad, Uruguay, and Venezuela.	Unknown.	Ground pools, pools along streams, swamps, and lakes all in full sunlight. Water with grassy margins.	Feeds on large mammals and refuses to feed on birds.	Unknown.	Unknown.
Coquillettidia arribalzagai	Oriboca	*Oryzomys capito*, *Proechimys guyanensis*, *Didelphis marsupialis*.	Brazil, Colombia, French Guiana, Nicaragua, Panama, Peru, and Suriname.	During the rainy season in tropical rain forests.	Larvae attach to roots of aquatic plants in permanent water.	Bites humans by day in forest.	Unknown.	Unknown.
Coquillettidia venezuelensis	Murutucu Oriboca Oropouche	Murutucu: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squimipes*, *Didelphis marsupialis*, *Marmosa cinerea*, *Bradypus tridactylus*, *Artibeus literatus*, *Artibeus jamaicensis*. Oriboca: *Oryzomys capito*, *Proechimys guyanensis*, *Didelphis marsupialis*. Oropouche: Primates (*Cebus*, *Alouatta*, *Saimiri*, *Saguinus*), sloths (*Bradypus*), *Zygodontomys*, and possibly wild birds.	Argentina, Belize, Brazil, Colombia, Costa Rica, El Salvador, French Guiana, Guatemala, Guyana, Mexico, Nicaragua, Panama, Peru, Suriname, Trinidad, and Uruguay.	Murutucu and Oriboca transmission occur during the rainy season in tropical rain forests (November to March). Oropouche epidemics occur during the rainy season (November to March).	Larvae attach to roots of aquatic plants in permanent water pools.	Bites humans in the forest, especially where there is secondary growth.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Culex coronator	Caraparu (Brazil, Panama)	*Oryzomys capito*, *Oryzomys laticeps*, *Proechimys guyanensis*, *Nectomys squamipes*, *Zygodontomys brevicauda*, *Heteromys anomalus*.	Argentina, Belize, Brazil, Bolivia, Colombia, French Guiana, Guatemala, Honduras, El Salvador, Mexico, Panama, Paraguay, Peru, Suriname, Trinidad, United States, and Venezuela.	During the rainy season (November to March) in tropical rain forests.	Ground pools, seeps, streams, artificial containers, bromeliads, and bamboo. Stagnant and slow-flowing water, shaded or unshaded.	Commonly considered not to feed on humans, but observed to be a major human biter in the Amazon Basin.	Unknown.	Unknown.
Culex gnomatus	VEE (Ecuador, Peru)	Many mammals and birds, but equines are key reservoirs with high viremias.	Brazil, Ecuador, and Peru.	VEE virus activity begins at the end of the rainy season and disappears during the dry season.	Unknown.	Unknown.	Unknown.	Unknown.
Culex nigripalpus	Caraparu (Brazil, Panama) EEE (Peru) St. Louis Encephalitis (SLE) (Colombia, Ecuador, Guatemala, Jamaica, Trinidad) Vesicular Stomatitis	Caraparu: *Oryzomys capito*, *Oryzomys laticeps*, *Proechimys guyanensis*, *Nectomys squamipes*, *Zygodontomys brevicauda*, *Heteromys anomalus*. EEE: Birds, particularly passerines. SLE: Wild birds. Vesicular Stomatitis: Poorly understood but primarily a disease of livestock (bovines and equines).	Bahamas, Barbados, Belize, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, French Guiana, Guatemala, Guyana, Jamaica, Mexico, Panama, Puerto Rico, Suriname, Trinidad, United States, and Venezuela.	Caraparu transmission occurs during the rainy season (November to March) in tropical rain forests. EEE virus activity occurs throughout the year (Peru). SLE: unknown.	Wide variety of habitats, including ground pools, ditches, grassy pools, crab holes, permanent pools in swamps, artificial containers, beaches, boats, and axils of bromeliads.	Feeds on humans, sometimes entering houses or tents.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Culex ocossa	VEE (Ecuador, Peru) Apeu (Brazil) Caraparu (Brazil, Panama) Itaqui (Brazil, Venezuela) Marituba (Peru) Murutucu Oriboca	Apeu: Marsupials (*Caluromys philander).* Caraparu: *Oryzomys capito*, *Oryzomys laticeps*, *Proechimys guyanensis*, *Nectomys squamipes*, *Zygodontomys brevicauda*, *Heteromys anomalus.* Itaqui: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Marmosa murina*, *Metachirus nudicaudatus.* Marituba: Marsupials (*Didelphis marsupialis*). Murutucu: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Didelphis marsupialis*, *Marmosa cinerea*, *Bradypus tridactylus*, *Artibeus literatus*, *Artibeus jamaicensis.* Oriboca: *Oryzomys capito*, *Proechimys guyanensis*, *Didelphis marsupialis.*	Argentina, Brazil, Colombia, Ecuador, Guyana, Panama, Suriname, and Venezuela.	VEE virus activity begins at the end of the rainy season and disappears when the dry season is underway. Apeu, Caraparu, Itaqui, Marituba, Murutuca and Oriboca transmission occur during the rainy season (November to March) in tropical rain forests.	Permanent pools, always associated with aquatic plants such as *Pistia*.	Endophagic.	Commonly rests on screens of windows.	Unknown.
Culex pedroi	EEE (Peru)	Birds, particularly passerines.	Argentina, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Mexico, Panama, Peru, Suriname, Tobago and Trinidad.	Virus activity occurs throughout the year (Peru).	Heavy shade in permanent bodies of water with abundant floatage.	Commonly bites humans but apparently prefers rodents. Has been known to feed on birds.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Culex portesi	Bimiti (Peru) Guama (Guama, Colombia) Itaqui (Brazil, Venezuela) Marituba (Peru) Murutucu Oriboca	Bimiti: *Oryzomys laticeps*, *Zygodontomys brevicauda*, *Heteromys anomalus*, *Proechimys guyanensis*. Guama: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp. Itaqui: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Marmosa murina*, *Metachirus nudicaudatus*. Marituba: Marsupials (*Didelphis marsupialis*). Murutucu: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Didelphis marsupialis*, *Marmosa cinerea*, *Bradypus tridactylus*, *Artibeus literatus*, *Artibeus jamaicensis*. Oriboca: *Oryzomys capito*, *Proechimys guyanensis*, *Didelphis marsupialis*.	Brazil, Colombia, French Guiana, Peru, Suriname, Trinidad, and Venezuela.	Bimiti virus activity begins at the end of the rainy season (March) and disappears during the dry season (May). Guama transmission occurs during the rainy season in tropical rain forests (November to March). Incubation period <10 days. Itaqui, Marituba, Murutucu and Oriboca transmission occurs during the rainy season (Novembers to March) in tropical rain forests.	Lowland swamp forests at elevations from sea level to 30 m. Larvae also found in deep shade of tree buttresses, root caves, and leafy swamp margins.	Unknown.	Unknown.	Unknown.
Culex quinquefasciatus	Oropouche	Primates (*Cebus*, *Alouatta*, *Saimiri*, *Saguinus*), sloths.	Associated with human settlements and widely distributed throughout the tropical and subtropical regions of the world.	Year-round where temperatures are favorable for mosquito development, but especially during the dry season when organic material concentrates in breeding areas.	Stagnant/ polluted water high in organic content, in ground seeps or in artificial containers. Breeds in clean and brackish water.	Preference for avian blood but will feed readily on mammals, including humans. Bites throughout night, but especially a few hours before and after midnight.	Rests during day in dark humid shelters, e.g., culverts, cellars, outhouses, chicken houses.	Routinely 200-300 m. Maximum: 1.3 km, but Hawaiian studies show that 4 km is common.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Culex spissipes	Bimiti (Peru) Caraparu (Brazil, Panama) Itaqui (Brazil, Venezuela) Oriboca	Bimiti: *Oryzomys laticeps, Zygodontomys brevicauda, Heteromys anomalus, Proechimys guyanensis.* Caraparu: *Oryzomys capito, Oryzomys laticeps, Proechimys guyanensis, Nectomys squamipes, Zygodontomys brevicauda, Heteromys anomalus.* Itaqui: *Oryzomys capito, Proechimys guyanensis, Nectomys squamipes, Marmosa murina, Metachirus nudicaudatus.* Oriboca: *Oryzomys capito, Proechimys guyanensis, Didelphis marsupialis.*	Belize, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guatemala, Honduras, Mexico, Panama, Peru, Suriname, Trinidad, and Venezuela.	Bimiti virus activity begins at the end of the rainy season (March) and disappears during the dry season (May). Caraparu, Itaqui and Oriboca transmission occur during the rainy season (November to March) in tropical rain forests.	Heavily or partially shaded margins of lakes in forests, margins of swamps, and in ground pools. Water is usually permanent and fresh, with abundant grassy and floating aquatic vegetation, or with dense accumulations of fallen leaves.	Has been collected at night in mouse-baited traps.	Unknown.	Unknown.
Culex taeniopus	Bimiti (Peru) Guama (Colombia, Peru) Ossa (Panama)	Bimiti: *Oryzomys laticeps, Zygodontomys brevicauda, Heteromys anomalus, Proechimys guyanensis.* Guama: *Oryzomys capito, Proechimys guyanensis, Nectomys squamipes, Oryzomys laticeps, Heteromys anomalus, Zygodontomys brevicauda, Coendou* spp. Ossa: *Proechimys semispinosus.*	Bahamas, Belize, Cayman Islands, Colombia, Costa Rica, Dominican Republic, French Guiana, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Puerto Rico, and Venezuela.	Bimiti virus activity begins at the end of the rainy season (March) and disappears when dry season is underway (May). Guama transmission occurs during the rainy season in tropical rain forests (November to March). Incubation period <10 days. Ossa transmission occurs during the rainy season in tropical rain forests (November to March).	Found in stagnant water in swamps and forests.	Unknown.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Culex vomerifer	Caraparu (Brazil, Panama) Guama (Colombia, Peru) Itaqui (Brazil, Venezuela) Murutucu Ossa (Panama)	Caraparu: *Oryzomys capito*, *Oryzomys laticeps*, *Proechimys guyanensis*, *Nectomys squamipes*, *Zygodontomys brevicauda*, *Heteromys anomalus*. Guama: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp. Itaqui: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Marmosa murina*, *Metachirus nudicaudatus*. Murutucu: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Didelphis marsupialis*, *Marmosa cinerea*, *Bradypus tridactylus*, *Artibeus literatus*, *Artibeus jamaicensis*. Ossa: *Proechimys semispinosus*.	Brazil, Colombia, Ecuador, French Guiana, Panama, Peru, Trinidad, and Venezuela.	Caraparu transmission occurs during the rainy season (November to March) in tropical rain forests. Guama transmission occurs during the rainy season in tropical rain forests (November to March). Incubation period <10 days. Itaqui, Murutucu and Ossa transmission occur during the rainy season (November to March) in tropical rain forests.	Treeholes, most often found in the forest canopy.	Unknown.	Unknown.	Unknown.
Culex (*Melanoconion*) spp.	SLE (Ecuador) VEE (Ecuador, Peru)	SLE: Wild birds. VEE: Many mammals and birds, but equines are key reservoirs with high viremias.	Unknown.	SLE: Unknown. VEE: Virus activity begins at the end of the rainy season and disappears during the dry season.	Unknown.	Unknown.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Haemagogus janthinomys	Mayaro (Bolivia, Colombia, Peru)	Callithricid primates (*Callithrix argentata* and *Callithrix humeralifer*) and passerine birds.	Argentina, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guyana, Honduras, Nicaragua, Panama, Paraguay, Peru, Suriname, Tobago and Trinidad, and Venezuela.	Disease found mainly in forests.	Treeholes, most often found in the forest canopy.	Bites humans during the day in the canopy of undisturbed rain forest.	Unknown.	Unknown.
Limatus durhamii	Caraparu (Brazil, Panama)	*Oryzomys capito*, *Oryzomys laticeps*, *Proechimys guyanensis*, *Nectomys squamipes*, *Zygodontomys brevicauda*, *Heteromys anomalus*.	Argentina, Belize, Bolivia, Brazil, Costa Rica, Dominican Republic, Ecuador, El Salvador, French Guiana, Guadaloupe, Grenada, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru, Suriname, Trinidad, and Venezuela.	During the rainy season (November to March) in tropical rain forests.	Fallen leaves and small containers with abundant decomposing plant matter.	Bites humans in disturbed forests during the day.	Unknown.	Unknown.
Limatus flavisetosus	Mayaro (Bolivia, Colombia, Peru) Wyeomyia (Colombia)	Callithricid primates (*Callithrix argentata* and *Callithrix humeralifer*) and passerine birds. *Wyeomyia*: "Mosquito."	Bolivia, Brazil, Colombia, French Guiana, Peru, and Suriname.	Disease found mainly in forests. *Wyeomyia*: Unknown.	Fallen leaves and small containers with abundant decomposed plant matter.	Bites humans mainly during the day at ground level in the forest.	Unknown.	Unknown.
Limatus spp.	Guama	*Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp.	Colombia, Peru.	During the rainy season in tropical rain forests (November to March). Incubation period <10 days.	Unknown.	Unknown.	Unknown.	Unknown.
Mansonia indubitans (Ecuador)	Vesicular Stomatitis	Poorly understood but primarily a disease of livestock (bovines and equines).	Bolivia, Brazil, Ecuador, Panama, Peru, Trinidad, and Uruguay.	Virus activity begins at the end of the rainy season and disappears when the dry season is underway.	Permanent water with abundant vegetation. Larvae use siphon to penetrate roots of aquatic plants for air.	Bites humans day or night, sometimes indoors. Vicious biter.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Mansonia spp.	Guama (Colombia, Peru) WEE (Ecuador)	Guama: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp. WEE: Epizootic transmission undefined, but passerine birds considered important reservoirs.	Guama: Colombia, Ecuador, Peru. WEE: Ecuador, Peru.	Guama: During the rainy season in tropical rain forests (November to March). Incubation period <10 days. WEE: unknown.	Unknown.	Unknown.	Unknown.	Unknown.
Psorophora albigenu	EEE (Peru) VEE (Peru)	EEE: Birds, particularly passerines. VEE: Many mammals and birds, but equines are key reservoirs with high viremias.	Argentina, Bolivia, Brazil, Ecuador, Paraguay, Peru, and Venezuela.	EEE virus activity throughout the year (Peru). VEE virus activity begins at the end of the rainy season and disappears when the dry season is underway.	Heavily shaded temporary ground pools.	Unknown.	Unknown.	Unknown.
Psorophora albipes (Colombia)	Mayaro (Bolivia, Colombia, Peru)	Callithricid primates (*Callithrix argentata* and *Callithrix humeralifer*) and passerine birds.	Bolivia, Brazil, Guatemala, Colombia, Honduras, Mexico, Peru, Suriname, Trinidad, and Venezuela.	Disease found mainly in forests.	Temporary ground pools.	Bites humans primarily during the day in the forest. Can be the dominant biting species.	Unknown.	Unknown.
Psorophora ferox	EEE (Peru) Ilheus (Colombia) Mayaro (Bolivia, Colombia, Peru) Oriboca	EEE: Birds, particularly passerines. Ilheus: Unknown. Mayaro: Callithricid primates (*Callithrix argentata* and *Callithrix humeralifer*) and passerine birds. Oriboca: *Oryzomys capito*, *Proechimys guyanensis*, *Didelphis marsupialis*.	Canada south to Argentina.	EEE Virus activity throughout the year (Peru). Ilheus: Unknown. Mayaro transmission occurs mainly in forests. Oriboca transmission occurs during the rainy season in tropical rain forests.	Temporary, shaded ground pools in forests.	Bites humans at ground level, usually in the forest during the day. A vicious biter of any warm-blooded animal, waits in vegetation and emerges to bite. Sometimes bites indoors.	Unknown.	Usually remains near larval site but has been observed to fly up to 2 km.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Psorophora pallescens	WEE (Ecuador)	Epizootic transmission undefined, but passerine birds considered important reservoirs.	Argentina, Bolivia, Ecuador and Paraguay.	Unknown.	Predacious on other mosquito larvae in temporary ground pools.	Has been observed to feed primarily on cattle, but also other large mammals and on chickens.	Unknown.	Unknown.
Psorophora spp.	Guama (Colombia, Peru)	*Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp.	Colombia and Peru.	During the rainy season in tropical rain forests (November to March). Incubation period <10 days.	Unknown.	Unknown.	Unknown.	Unknown.
Trichoprosopon digitatum	Bussuquara (Panama) SLE (Colombia, Ecuador) Wyeomyia (Colombia)	Bussuquara and Wyeomyia: "Mosquito". SLE: Wild birds.	Belize, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Mexico, Nicaragua, Panama, Peru, Suriname, and Venezuela.	Unknown.	Bamboo internodes, fallen fruits or nuts, fallen leaves, artificial containers (cans, tires, dishes, etc.), treeholes, *Heliconia* flower bracts, and leaf axils of bromeliads.	Bites humans, especially at ground level in the forest during the day, with greatest numbers in the evening. A vicious biter.	Unknown.	Unknown.
Trichoprosopon spp.	Guama (Colombia, Peru)	*Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp.	Colombia, Peru.	During the rainy season in tropical rain forests (November to March). Incubation period <10 days.	Unknown.	Unknown.	Unknown.	Unknown.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Wyeomyia aporonoma	Mayaro (Bolivia, Colombia, Peru) Wyeomyia (Colombia)	Mayaro: Callithricid primates (*Callithrix argentata* and *Callithrix humeralifer*) and passerine birds. Wyeomyia: "Mosquito."	Belize, Bolivia, Brazil, Colombia, Costa Rica, El Salvador, French Guiana, Grenada, Guatemala, Guyana, Honduras, Mexico, Panama, St. Vincent, and Venezuela.	Mayaro transmission is suspected to occur year-round, mainly in forests. Wyeomyia: unknown.	Leaf axils of terrestrial bromeliads.	Bites humans in the forest during the day in the canopy or at ground level.	Unknown.	Unknown.
Wyeomyia medioalbipes	Caraparu (Brazil, Panama) Wyeomyia (Colombia)	Caraparu: *Oryzomys capito*, *Oryzomys laticeps*, *Proechimys guyanensis*, *Nectomys squamipes*, *Zygodontomys brevicauda*, *Heteromys anomalus*. Wyeomyia: "Mosquito."	Brazil, Colombia, Panama, Suriname, and Trinidad.	Caraparu transmission occurs during the rainy season (November to March) in tropical rain forests. Wyeomyia: unknown.	Leaf axils of terrestrial bromeliads.	Unknown.	Unknown.	Unknown.
"Mosquitoes"	Guaroa (Colombia, Peru)	Human isolate.	Colombia, Peru.	Unknown.	Unknown.	Unknown.	Unknown.	Unknown.
Culicoides paraensis (Diptera: Ceratopogonidae)	Oropouche	Primates (*Cebus*, *Alouatta*, *Saimiri*, *Saguinus*), sloths.	From sea level to elevations where tropical rain forests begin.	Epidemics occur during the rainy season (November to March).	Eggs are laid in decaying vegetable matter. Decaying banana stocks, cut-off banana stumps and piled up cacao pods are primary breeding sources in peridomestic settings and plantations. Rains provide moisture required for larval development in the decaying vegetation.	Exophagic or endophagic. Bites lower extremities, especially ankles. Inflicts painful bites capable of causing severe tissue reactions. Strictly daytime biters. Small peak at noon and large peak beginning 1 hour before and continuing to sunset. Increased activity right after rain showers.	Endophilic and exophilic.	Unknown, but probably less than 1 km.

Appendix A.3. (Cont'd)

VECTOR	ARBOVIRUS	ARBOVIRUS RESERVOIR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Lutzomyia spp. (Diptera: Psychodidae)	Arboledas (Colombia) Buenaventura (Colombia) Guama (Colombia, Peru) Mariquita (Colombia) Vesicular Stomatitis	Arboledas and buenaventura: unknown. Guama: *Oryzomys capito*, *Proechimys guyanensis*, *Nectomys squamipes*, *Oryzomys laticeps*, *Heteromys anomalus*, *Zygodontomys brevicauda*, *Coendou* spp. Mariquita: unknown. Vesicular Stomatitis: Poorly understood but primarily a disease of livestock (bovines and equines).	Colombia, Peru.	Arboledas, Buenaventura and Mariquita transmission coincides with increases in sand fly populations during the rainy season (November to March). Guama transmission occurs during the rainy season in tropical rain forests (November to March). Incubation period <10 days. Vesicular stomatitis virus activity begins at the end of the rainy season and disappears when the dry season is underway.	Unknown.	Unknown.	Unknown.	Unknown.
Simulium exiguum (Diptera: Simuliidae)	Vesicular Stomatitis	Poorly understood but primarily a disease of livestock (bovines and equines).	Colombia	Virus activity begins at the end of the rainy season and disappears during the dry season.	Unknown.	Unknown.	Unknown.	Unknown.

Appendix A.4. Vector Ecology Profile: Reduviid Vectors of Chagas Disease in Peru.

VECTOR	GEOGRAPHIC DISTRIBUTION	POTENTIAL HOSTS	TRANSMISSION SEASON	BIONOMICS/HABITAT INFORMATION	BITING BEHAVIOR
Triatoma infestans	Widely distributed up to 4,100 m in the inter-Andean valleys of central to southern Peru.	Unknown.	Unknown.	Domestic and peridomestic – rarely found in forest areas. Hides during day among household items (bed, clothing, etc.) and in thatched constructed roof/walls. Peridomestic infestations of poultry, pigeons, rabbit pens and larger livestock shelters. Tolerates temperatures between 10°C-37°C. Prefers warm climate and low humidity. Populations peak during rainy season. Life cycle may extend over 2 years, 5 nymphal stages, adults live as long as 16 months. All stages may become infective. As many as 240 eggs are laid freely, not glued to substrate surfaces. Two generations per year. Rests in cracks/crevices of upper walls and rafters/roof.	Strongly anthropophilic and zoophilic. Sylvatic host associations include didelphids, *Microcavia, Graomys, Galea* spp. Aggressive feeder. Thermotrophic and attracted to CO_2. Painless bite with little reaction. Feeds every few weeks.
Triatoma dimidiata	Exclusively along the Pacific Coast of northern Peru.	Unknown.	Unknown.	Domestic/peridomestic in urban and rural structures. Prefers densely forested areas. Infected with *T. cruzi* for life. Maintenance of sylvatic *T. cruzi* cycle more important than domestic contact with man. Frequently covered with soil particles. In armadillo burrows. Attracted to light.	Strongly zoophilic, weakly anthropophilic. Feeds 10-20 minutes. Flagellates in feces 12-15 days post-infected meal. Bite produces pruritis and erythema.
Rhodnius ecuadoriensis	Andean valleys of northern Peru.	Unknown.	Unknown.	Domestic, peridomestic, and sylvatic. Collected in guinea pig pens and in hollow trees. Domiciliary habits of recent origin.	Secondarily anthropophilic.
Panstrongylus herreri	Northern Peru at altitudes up to 1,500 m.	Unknown.	Unknown.	Colonizes human dwellings and feeds on guinea pigs. Peridomestic in chicken houses.	Secondarily anthropophilic.
Panstrongylus chinai	Pacific slopes of Andes from sea level to 1,500 m. Amazon drainage basin.	Unknown.	Unknown.	Naturally infected with *T. cruzi* – weak potential vector. Has been found in homes but not truly domestic. Attracted to lights. Evidence of colonization – presence of nymphs.	Secondarily anthropophilic.

Appendix A.4. (Cont'd)

VECTOR	GEOGRAPHIC DISTRIBUTION	POTENTIAL HOSTS	TRANSMISSION SEASON	BIONOMICS/HABITAT INFORMATION	BITING BEHAVIOR
Triatoma carrioni	Between 1,000 and 2,650 m.	Unknown.	Unknown.	Semi-domestic species, attacking man and horses. Has been collected in wild animal burrows.	Secondarily anthropophilic.

Appendix A.5. Vector Ecology Profile: Flea Vectors of Plague in Peru.

VECTOR	GEOGRAPHIC DISTRIBUTION	POTENTIAL HOSTS	TRANSMISSION SEASON	BIONOMICS/HABITAT INFORMATION	ASPECTS OF TRANSMISSION
Xenopsylla cheopis	Primary vector at elevations below 2,800 m countrywide, although *X. cheopis* will occur at higher elevations.	*Rattus rattus*, *Rattus norvegicus*, *Cavia porcellus*	Unknown.	300-400 ovoid white eggs are deposited in the nest or burrow of the host at a rate of 2-6/day. The eggs hatch in 9-13 days. Three larval stadia are legless and eyeless, lasting 32-34 days. Pupae spin a silken cocoon and adults emerge in 25-30 days. Development occurs in nest. Adults live up to 158 days at 20°C and 90-94% relative humidity.	Voracious feeder, feeding frequently for short periods. Proventricular blockage occurs below 27°C. Blockage occurs 12-21 days after ingesting plague bacilli. Found to feed readily on 75 different hosts, including man. Can jump 20 cm. Burrowing *Rattus* spp. usually harbor more *X. cheopis* than those confined to surface habitats.
Pulex irritans and *P. simulans*	Implicated as primary urban vector at elevations above 2,800 m.	*Rattus rattus*, *Rattus norvegicus*, *Cavia porcellus* *Sus scrofa* *Canis familiaris*	Unknown.	Broader temperature tolerance than *X. cheopis*. Eggs laid indiscriminately in the environment in peridomestic setting. Larvae and pupae develop in the soil. Adults live free in environment and access hosts by jumping, feeding quickly and jumping off.	Blockage of the proventriculus rarely occurs in *Pulex* spp. Voracious feeders, feeding frequently. Can jump 30 cm vertically.
Nosopsyllus londiniensis	May replace *X. cheopis* above 2,800 m, although *X. cheopis* may still be present.	*Rattus* spp.	Unknown.	Little known about life cycle.	Occurs in greater numbers on *Rattus* spp. in burrow systems than on those in buildings and above ground harborage (e.g., woodpiles, debris).
Tiamastus cavicola	Potential vector found in homes of rural citizens that rear guinea pigs (*Cavia porcellus*) for food at higher elevations.	*Cavia porcellus*	Unknown.	Adults are found on the guinea pigs and all stages found in bedding.	Transport of *C. porcellus* from one area to another, as a food commodity, is a potential mechanism for spread of plague, particularly from high elevations to lower elevations where *Rattus* and *X. cheopis* are prevalent.
Polygenis litargus	Proven sylvatic vector with probable association with *Sciurus stramineus* in northern departments of Piura, Cajamarca, La Libertad, and Lambayeque.	*Sciurus stramineus* *Oryzomys* spp. *Akodon mollis* spp.	Unknown.	Fleas found in nests and on bodies of *Sciurus stramineus*.	Importance only in maintenance of enzootic plague.

Appendix A.6. Vector Ecology Profile: Sand Fly Vectors of Leishmaniasis in Peru.

VECTOR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	BIONOMICS/HABITAT INFORMATION	BITING BEHAVIOR
Lutzomyia flaviscutellata	Vector of *Leishmania* parasites in southeastern lowlands of Amazon Basin in departments of Loreto and Madre de Dios.	Populations present throughout year, but significant populations begin toward end of dry season (August) and declines as rainy season commences.	Found in dry secondary forests. Species has been colonized in the laboratory. Egg to adult averages 40.5 days. Males emerge before females. Females and males live 17-41 days (av. 27) and 2-12 days (av. 6), respectively. Requires blood meal for egg development. Lay 165 eggs/female. Optimal larval rearing 20-26°C and adults 23-27°C at 95-98% relative humidity.	Strongly attracted to rodents and marsupials, but will bite humans entering their habitat. Females will feed as many as four times during life. Successful biting collections have been taken during the first four hours after dark. Attracted to armadillos and guinea pigs in Disney traps.
Lutzomyia umbratilis	Vector of *Leishmania* parasites in northeastern lowland Amazon Basin in department of Loreto.	Unknown in Peru, but lives in canopy most of year and is abundant at ground level for about two weeks at beginning of rainy season in French Guiana.	Adults found in primary rain forests. Commonly collected on trunks of Niamboka (*Pouteria guianensis*) and Kopi (*Goupia glabra*) trees and associated with *Lutzomyia rorotaensis* in French Guiana.	Anthropophilic.
Lutzomyia peruensis	Primary vector of "uta" in the Purisima Valley, Ancash Department, with peak populations between 2,250-2,750 m. Occurs in the west-facing valleys of the Andean cordillera in the departments of Piura, La Libertad, Ancash, Cajamarca, and Lima. Implicated as a vector of *Bartonella bacilliformis*.	Populations peak during wet season (January to April). Sand fly analyses indicate that infected flies are found primarily in April (coinciding with known transmission of "uta").	Habitats are close to domestic dwellings. Populations increase above 2,250 m (Ancash Department).	More endophilic and anthropophilic during wet season. Females enter houses and feed, while males tend to remain outdoors. Biting activity begins at dusk and continues until ca. midnight at lower elevations (<2,000 m), especially during the warmer wet season. At higher elevations (>2,000 m), especially during the cooler dry season, biting activity lasts only a few hours after dusk, or ceases altogether.

Appendix A.6. (Cont'd)

VECTOR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	BIONOMICS/HABITAT INFORMATION	BITING BEHAVIOR
Lutzomyia verrucarum	Secondary vector in west-facing valleys of the Andean cordillera in the departments of Piura, La Libertad, Ancash, Lima, and Cajamarca (1,100-3,200 m). Implicated as a vector of *Bartonella bacilliformis*.	Most abundant in April and May and more abundant than *Lu. peruensis* throughout the year (determined by light traps and human bait collections).	This species is most easily collected with light traps, but can also be collected on human bait. Populations increase below 2,250 m (Ancash Department).	More exophilic during wet season. Not attracted to humans farther that 5 m away. Biting activity similar to *Lu. peruensis*, but endophilic behavior decreases during warmer wet season.

Appendix B: Arthropod Species

Appendix B.1: Species of Mosquitoes Reported from Peru*

Aedeomyia (*Aedeomyia*)
- *squamipennis*

Aedes (*Howardina*)
- *fulvithorax*

Aedes (*Ochlerotatus*)
- *angustivittatus*
- *condolescens*
- *crinifer*
- *fulvus*
- *hastatus*
- *milleri*
- *scapularis*
- *serratus*
- *taeniorhynchus*

Aedes (*Protomacleaya*)
- *argyrothorax*

Aedes (*Stegomyia*)
- *aegypti*

Anopheles (*Anopheles*)
- *calderoni*
- *eiseni*
- *fluminensis*
- *mattagrossensis*
- *mediopunctatus*
- *neomaculipalpus*
- *peryassui*
- *pseudopunctipennis*
- *punctimacula*
- *shannoni*

Anopheles (*Kerteszia*)
- *bambusicolus*
- *boliviensis*
- *cruzii*
- *homunculus*
- *neivai*

Anopheles (*Nyssorhynchus*)
- *albimanus*
- *bennarochi*
- *darlingi*
- *nuneztovari*
- *oswaldoi*
- *rangeli*
- *triannulatus*
- *trinkae*

Anopheles (*Stethomyia*)
- *acanthotorynus*
- *kompi*
- *nimbus*
- *thomasi*

Chagasia bathana
- *bonneae*

Coquillettidia (*Rhynchotaenia*)
- *albicosta*
- *arribalzagae*
- *hermanoi*
- *juxtamansonia*
- *lynchi*
- *nigricans*
- *venezuelensis*

Culex (*Anoedioporpa*)
- *bamborum*

Culex (*Carrollia*)
- *infoliatus*
- *urichii*

Culex (*Culex*)
- *apicinus*
- *archegus*
- *articularis*
- *camposi*
- *coronator*
- *diphlophylium*

habilitator
mollis
quinquefasciatus
squatus

Culex (*Lutzia*)
allostigma

Culex (*Melanoconion*)
bastagarius
educator
erraticus
gnomatus
ocossa
pedroi
portesi
putamayensis
taeniopus
theobaldi
vomerifer

Culex (*Phenacomyia*)
corniger

Deinocerites pseudes

Haemagogus (*Haemagogus*)
baresi
janthinomys

Johnbelkinia longipes

Limatus durhamii
flavisetosus

Mansonia (*Mansonia*)
amazonensis
flaveola
humeralis
indubitans
pseudotitillans
titillans

Orthopodomyia fascipes

Psorophora (*Grabhamia*)
cingulata
confinnis

Psorophora (*Janthinosoma*)
albigenu
circumflava
ferox
lutzii

Psorophora (*Psorophora*)
lineata

Sabethes (*Peytonulus*)
undosus

Sabethes (*Sabethes*)
belisarioi
quasicyaneus
schnusei
tarsopus

Sabethes (*Sabethinus*)
idiogenes

Toxorhynchites (*Lynchiella*)
bambusicola
haemorrhoidalis

Trichoprosopon digitatum
pallidiventer

Uranotaenia (*Uranotaenia*)
apicalis
calosomata
geometrica
hystera
lowii
pallidoventer
pulchemmia
socialis

Wyeomyia. (*Dodecamyia*)
aphobema

Wyeomyia (*Exallomyia*)
carrilloi

Wyeomyia aporonoma
belkini

***References: Knight and Stone 1977, Knight 1978**

Appendix B.2: Species of Sand Flies Reported from Peru*

Lutzomyia (*Evandromyia*)
- *cerqueirai*
- *infraspinosa*[2]
- *sipani*

Lutzomyia (*Helcocyrtomyia*)
- *ayacuchensis*[3 (Ecuador)]
- *blancasi*
- *caballeroi*
- *hartmanni*[1]
- *imperatrix*
- *kirigetiensis*
- *noguchii*
- *osornoi*
- *peruensis*[1,6 (Ancash, Peru)]
- *pescei*[1]
- *reclusa*
- *tejadai*[1]
- *tortura*[1,2]

Lutzomyia (*Lutzomyia*)
- *battistinii*
- *bicornuta*
- *evangelistai*
- *gomezi*[1, 3]
- *lichyi*[1]
- *sherlocki*

Lutzomyia (Species Group *Verrucarum*)
- *deorsa*
- *nevesi*[1]
- *nuneztovari*[1,3 (Bolivia)]
- *serrana*[1]
- *verrucarum*[1,3 (Ancash, Peru), 7 (Verrugas Canyon ,Peru), 2]

Lutzomyia (*Micropygomyia*)
- *cayennensis cayennensis*
- *micropyga*

Lutzomyia (Species Group *Oswaldoi*)
- *longipennis*
- *machupicchu*
- *quechua*
- *rorotaensis*
- *trinidadensis*

Lutzomyia (*Nyssomyia*)
- *antunezi*[1]
- *flaviscutellata*[1]
- *olmeca bicolor*[1]
- *richardwardi*[1]
- *shawi*[1,3]
- *whitmani*[4]
- *yuilli pajoti*[1]
- *yuilli yuilli*[1]

Lutzomyia (*Pintomyia*)
- *christenseni*[2]
- *damascenoai*
- *fischeri*[1]

Lutzomyia (*Pressatia*)
- *calcarata*
- *choti*
- *tricantha*
- *trispinosa*

Lutzomyia (Species Group *Baityi*)
- *gorbitzi*
- *mouchoti*

Lutzomyia (*Psathyromyia*)
- *abonnenci*
- *campbelli*
- *cusquena*
- *dendrophyla*[1]
- *dendrophyla*
- *punctigeniculata*
- *scaffi*
- *shannoni*[1]

Lutzomyia (Species Group *Aragaoi*)
- *abunaensis*
- *aragaoi*
- *barettoi barrettoi*
- *brasiliensis*
- *coutinhoi*
- *runoides*

Lutzomyia (Species Group *Dreisbachi*)
- *dresbachi*
- *ruparupa*

Lutzomyia (*Psychodopygus*)
- *amazonensis*
- *ayrozai*[1]
- *carrerai carrerai*
- *chagasi*[1,4] (Northern Brazil)
- *claustrei*[3]
- *davisi*[1]
- *geniculata*[1]
- *hirsuta hirsuta*[1,3] (Para State, Brazil)
- *lainsoni*
- *llanosmartinsi*
- *nocticola*
- *paraensis*
- *yucumensis*[4] (Bolivia)

Lutzomyia (Species Group *Saulensis*)
- *saulensis*

Lutzomyia (*Sciopemyia*)
- *preclara*
- *servulolimai*
- *sordellii*

Lutzomyia (Species Group *Migonei*)
- *cortelezzii*
- *migonei*[1]
- *sallesi*
- *walkeri*

Lutzomyia (*Trichophoromyia*)
- *acostai*
- *auraensis*
- *clitella*
- *howardi*
- *incasica*
- *loretoensis*
- *napoensis*
- *nemorosa*
- *omagua*
- *sinuosa*
- *ubiquitalis*[1,5] (Para State, Brazil)

Lutzomyia (*Trichopygomyia*)
- *elegans*

Lutzomyia (*Viannamyia*)
- *caprina*
- *furcata*[2]

Ungrouped *Lutzomyia*
- *oligodonta*
- *pia*[1]

Warileya phlebotomanica

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[1] Anthropophilic
[2] Sand fly likely occurs, but not confirmed
[3] *Leishmania* (species not confirmed)
[4] *Leishmania brasiliensis*
[5] *Leishmania lainsoni*
[6] *Leishmania peruviana*
[7] Bartonellosis

***Reference: Young and Duncan 1994**

Appendix B.3: Species of Kissing Bugs Reported from Peru*

Belminus peruvianus[2] (Maranon Valley)

Eratyrus mucronatus[2] (east of Andes)

Microtriatoma trinidadensis[2]

Panstrongylus chinai[1]
Panstrongylus geniculatus
Panstrongylus herreri[1] (northern Peru)
Panstronglyus lignarius (northern Peru)
Panstrongylus rufotuberculatus

Rhodnius ecuadoriensis[1] (northern Peru)
Rhodnius pictipes
Rhodnius robustus

Triatoma carrioni[1] (northern Peru)
Triatoma dimidiata[1]
Triatoma infestans[1]

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[1] Anthropophilic species that colonize human habitations and are naturally infected with *Trypanosoma cruzi*.
[2] Little or no association with man.

***Reference: Brenner and Stoka 1987**

Appendix B.4: Species of Ticks and Their Hosts Reported from Peru*

Tick Species	**Hosts**
Argasidae	
Antricola sp.	*Pteronotus* (naked-backed bat)
Argas cucumerinus	seabirds
Argas dalei	*Athene cunicularia* (burrowing owl)
Argas magnus	chickens, pigeons
Argas miniatus	poultry
Argas moreli	chickens, humans
Argas neghmei	
Argas persicus	chickens, humans
Ornithodoros amblus	seabirds
Ornithodoros furcosus	humans, pigs
Ornithodoros hasei	*Artibeus* (tropical fruit bats)
Ornithodoros peruvianus	*Desmodus rotundus* (vampire bat), *Glossophaga* spp. (leaf-nosed bats)
Ornithodoros rudis	
Ornithodoros spheniscus	*Spheniscus humboldtii* (penguin)
Ornithodoros talaje	sea birds
Otobius megnini	dogs, cattle, horses, sheep, humans
Ixodidae	
Amblyomma cajennense	cattle, horses, humans
Amblyomma coelebs	*Tapirus* spp.
Amblyomma crassum	tortoises
Amblyomma dissimile	snakes
Amblyomma geayi	*Bradypus*, *Choloepus* (sloths)
Amblyomma humerale	*Geochelone denticulata* (tortoise)
Amblyomma incisum	*Tapirus terrestris* (tapir)
Amblyomma maculatum	cattle, horses, dogs, goats
Amblyomma naponense	*Tamandua* (anteater), *Tayassu* (peccary)
Amblyomma ovale	dogs, cattle
Amblyomma parvitarsum	*Lama glama* (llama), *Vicugna vicugna*
Amblyomma rotundatum	snakes, lizards, toads, tortoises
Amblyomma scalpturatum	tapirs, humans
Amblyomma tigrinum	dogs, wild carnivores
Amblyomma varium	*Bradypus, Choloepus, Tayassu*
Anocentor nitens	cattle, donkeys, horses, mules

Boophilus annulatus	cattle, horses, sheep
Boophilus microplus	cattle
Dermacentor imitans	*Tayassu pecari* (collared peccary), humans
Haemaphysalis leporispalustris	*Sylvilagus brasiliensis* (cottontail rabbit), *Proechimys guyannensis* (spiny rat)
Ixodes affinis	*Oryzomys xantheolus* (rice rat), *Sigmodon hispidus* (cotton rat)
Ixodes andinus	*Calomys sorellus* (vesper mouse), *Phyllotis darwini* (leaf-eared mouse)
Ixodes auritulus	birds
Ixodes fuscipes	*Agouti paca* (paca), *Dasyprocta leporina* (agouti), *Felis pardalis* (ocelot)
Ixodes luciae	*Didelphis albiventris* (opossum), *Mazama* spp. (brocket deer), *Oryzomys xantheolus*
Ixodes nectomys	*Nectomys squamipes* (water rat)
Ixodes nuttalli	*Lagidium peruanum* (mountain viscacha)
Ixodes pararicinus	cattle, horses
Ixodes pomerantzi	*Sylvilagus brasiliensis*
Ixodes tropicalis	*Dactylomys boliviensis* (coro-coros)
Rhipicephalus sanguineus	dogs, humans

***Reference: Need et al. 1991**

Appendix B.5: Species of Fleas and Their Hosts Reported from Peru*

Flea Species	Hosts
Ceratophyllidae	
Nosopsyllus fasciatus [1,2,3]	*Rattus* (rats)
Nosopsyllus londiniensis	*Cavia* (guinea pigs), *Mus, Phyllotis* (leaf-eared mice), *Rattus* (rats)
Plusaetis dolens quitanus	*Akodon* (grass mice)
Plusaetis equatoris	*Akodon* (grass mice), *Oryzomys* (rice rats), *Rhipidomys* (climbing mice)
Ctenophthalmidae	
Agastopsylla hirsutior	*Akodon* (grass mice)
Agastopsylla nylota nylota	*Akodon* (grass mice)
Agastopsylla pearsoni	*Akodon* (grass mice)
Neotyphloceras crassispina crassispina	*Phyllotis* (leaf-eared mice)
Neotyphloceras rosenbergi [2]	*Sigmodon* (cotton rats), *Thomasomys* (Thomas's paramo mice), Marsupials
Leptopsyllidae	
Leptopsylla segnis	*Akodon* (grass mice), *Cavia* (guinea pigs), *Mus* (house/rice field mice), *Rattus* (rats)
Pulicidae	
Cediopsylla spillmanni [1,2]	*Cavia porcellus* (guinea pigs)
Ctenocephalides canis [1]	*Canis* (dogs), *Felis* (cats)
Ctenocephalides felis felis [1]	*Canis* (dogs), *Felis* (cats), *Rattus* (rats)
Echidnophaga gallinacea	Multiple domestics animals
Euhoplopsyllus andensis	*Sylvilagus* (cottontail rabbits)
Euhoplopsyllus manconis	*Sylvilagus* (cottontail rabbits)
Hectopsylla eskeyi [1,2,3]	*Cavia* (guinea pigs)
Hectopsylla suarezi [1,2]	*Cavia* (guinea pigs), *Oryzomys* (rice rats), *Rattus* (rats), *Sigmodon* (cotton rats)
Pulex irritans [1]	*Canis* (dogs), *Cavia* (guinea pigs), *Conepatus* (hog-nosed skunks), *Felis* (cats), Humans, *Lagostomus* (plains viscacha)
Pulex simulans	*Cavia* (guinea pigs)
Tunga penetrans [1]	*Canis* (dogs), *Cavia* (guinea pigs), *Felis* (cats), *Rattus* (rats), *Sus* (pigs)
Xenopsylla cheopis [1]	*Cavia* (guinea pigs), *Rattus* (rats)

Pygiopsyllidae

Ctenidiosomus spillmanni	*Akodon* (grass mice), *Oryzomys* (rice rats), *Thomasomys* (Thomas's paramo mice)

Rhopalopsyllidae

Ayeshaepsylla thurmanni	*Cavia* (guinea pigs), *Oligoryzomys* (rice rats), *Rattus* (rats)
Delostichus phyllotis	*Phyllotis* (leaf-eared mice)
Delostichus xenurus	*Lagidium* (mountain viscachas)
Ectinorus claviger	*Phyllotis* (leaf-eared mice)
Ectinorus hecate	*Oncifelis* (cats)
Ectinorus hertigi	*Ctenomys* (tuco tucos)
Ectinorus pearsoni	*Akodon* (grass mice), *Phyllotis* (leaf-eared mice)
Ectinorus sentus	*Lagidium* (mountain viscachas), *Lagostomus* (plains viscachas)
Ectinorus viscachae	*Lagidium* (mountain viscachas)
Ectinorus ineptus	*Auliscomys*, *Phyllotis* (leaf-eared mice)
Gephyropsylla klagesi klagesi	*Oryzomys* (rice rats)
Polygenis bohlsi bohlsi	*Oryzomys* (rice rats)
Polygenis brachinus	*Akodon* (grass mice), *Oryzomys* (rice rats)
Polygenis impavidus	*Didelphis* (opossums), *Thomasomys* (Thomas's paramo mice)
Polygenis litargus [2,3]	*Akodon* (grass mice), *Oryzomys* (rice rats), *Rattus* (rats), *Rhipidomys* (climbing mice), *Sciurus* (tree squirrels)
Polygenis litus	*Sciurus* (tree squirrels)
Polygenis rimatus	*Akodon* (grass rats), *Oryzomys* (rice rats)
Polygenis roberti beebei	*Dasypus* (long-nosed armadillos), *Oryzomys* (rice rats)
Rhopalopsyllus australis tupinus	Dasypodidae (armadillos)
Rhopalopsyllus cacicus	*Akodon* (grass mice), *Cavia* (guinea pigs), *Phyllotis* (leaf-eared mice), *Sylvilagus* (cottontail rabbits)
Rhopalopsyllus lugubris lugubris	*Didelphis* (opossum)
Tetrapsyllus bleptus	Multiple hosts
Tetrapsyllus comis	*Akodon* (grass mice), *Sigmodon* (cotton rat), *Thomasomys*(Thomas's paramo mice)
Tetrapsyllus elutus	*Akodon* (grass mice)
Tetrapsyllus tristis	*Akodon* (grass mice), *Ctenomys* (tuco tucos)
Tiamastus cavicola [2,3]	*Cavia* (guinea pigs), *Oryzomys* (rice rats), *Rattus* (rats)

Stephanocircidae

Cleopsylla townsendi	Multiple hosts
Craneopsylla minerva minerva	*Phyllotis* (leaf-eared mice)
Nonnapsylla rothschildi wagneri	*Galea* (yellow-toothed cavies)
Plocopsylla achilles	*Oryzomys* (rice rats), *Thomasomys* (Thomas's paramo mice)
Plocopsylla enderleini	*Chinchillula* (altiplano chinchilla mouse)
Plocopsylla inti	*Phyllotis* (leaf-eared mice)
Plocopsylla pallas	
Tiarapsylla bella	*Felis* (cats)
Tiarapsylla titschacki	*Lagidium* (mountain viscachas)

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[1]Anthropophilic
[2]Found naturally infected with plague
[3]Transmitted plague experimentally in the laboratory
Genera of known host(s) and their common names are listed to the right of each species.
Bat and bird fleas have not been implicated in disease transmission and are not included.

***References: Johnson 1957, Lewis 1972, 1973, 1974a, b, c, 1975**

Appendix B.6: Species of Black Flies Reported from Peru*

Simulium (*Cerqueirellum*)
- *argentiscutum*

Simulium (*Ectemnaspis*)
- *bicoloratum*
- *ignescens*
- *romanai*
- *rubiginosum*

Simulium (*Hemicnetha*)
- *paynei*
- *seriatum*

Simulium (*Psaroniocompsa*)
- *jujuyense*

Simulium (*Psilopelmia*)
- *dinellii*
- *escomeli*
- *lutzianum*

Simulium (*Pternaspatha*)
- *albicinctum*
- *albilineatum*
- *barbatipes*
- *herreri*
- *prodexargenteum*
- *strigidorsum*
- *yacuchuspi*

Simulium (*Simulium*)
- *metallicum*

Simulium (*Trichodagmia*)
- *chalcocoma*
- *huairayacu*
- *lahillei*

Simulium not placed in subgenus
- *argentatum*
- *blancasi*
- *costaricense*
- *flavipictum*
- *macca*
- *strigatum*
- *townsendi*

***Reference: Kim and Merritt 1987**

Appendix B.7: Species of Scorpions Reported from Peru*

Bothriuridae

Bothriurus inermis (Apurimac Department)

Buthidae

Tityus bastosi (Loreto Department)
Tityus demangei (Amazonas Department)
Tityus ecuadoriensis (Cajamarca and Cuzco Departments)
Tityus footei (Apurimac, Ayacucho, and Cuzco Departments)
Tityus gasci (Loreto Department)
Tityus silvestris (Loreto Department)
Tityus simonsi (Amazonas Department)
Tityus soratensis (Puno Department)

Chactidae

Chactopsis insignis (Loreto Department)

Vaejovidae

Hadruroides aguilari (Lima Department)
Hadruroides charcasus (Northern Peru)
Hadruroides lunatus (Lima Department)
Hadruroides mauryi (Inter-Andean valleys of south central Peru, 2,700-3,000 m)

***Reference: Polis 1990**

Appendix C: Species of Venomous Snakes from Peru*, **

Elapidae

Leptomicrurus narduccii (Amazonian slopes of Andes)
Leptomicrurus schmidti (considered *L. scutiventris* by some herpetologists)
Micrurus ancoralis (likely occurs, but not confirmed)
Micrurus annellatus spp. (Amazonian slopes of Andes)
Micrurus bocourti (Pacific lowland of northwestern Peru)
Micrurus catamayensis (likely occurs, but not confirmed)
Micrurus filiformis (northeastern Peru)
Micrurus frontalis [1, 4, 6, 10] (giant coral snake, northern Peru)
Micrurus frontifasciatus (likely occurs in northeast Loreto Department, but not confirmed)
Micrurus hemprichii (upper Amazon)
Micrurus langsdorffi (upper Amazonian region of northeastern Peru)
Micrurus lemniscatus [6] (Amazonian region)
Micrurus margaritiferus (east of central Peruvian Andes)
Micrurus mertensi (northwestern Peru)
Micrurus mipartitus [6, 10]
Micrurus peruvianus (northeastern Peru)
Micrurus psyches (northeastern Peru)
Micrurus putumayensis (northeastern Peru)
Micrurus spixii [6] (southeastern Peru)
Micrurus steindachneri (likely occurs on eastern slopes of Andes in north central Peru, but not confirmed)
Micrurus surinamensis (Amazon region)
Micrurus tschudii (Pacific slopes from north to south)

Viperidae

Bothriopsis bilineata (emerald pit viper, eastern Peru)
Bothriopsis oligolepis
Bothriopsis peruviana (southeastern Peru)
Bothriopsis taeniata (east of Andes)
Bothrops andianus (Cuzco and Puno Departments, 2,400-3,000 m)
Bothrops atrox [2, 6, 8, 9, 10, 11] (barba amarilla, equatorial forests)
Bothrops barnetti (northern coastal areas)
Bothrops brazili (equatorial forests)
Bothrops microphthalmus (Amazonian forests)
Bothrops monticelli (1,000-1,500 m)
Bothrops neuwiedi [1, 2, 3, 4] (Wied's lance head viper, likely occurs, but not confirmed)
Bothrops pictus (coastal Peru)
Bothrops pulcher (eastern Amazonian lowlands)
Bothrops roedingeri (coastal deserts, Ica Department)

Crotalus durissus terrificus [1, 2, 3, 4, 5, 6, 8, 9, 11] (cascavel or tropical rattlesnake, in dry regions)
Lachesis muta [2, 4, 6, 10, 9, 11] (bushmaster, equatorial forests)
Porthidium hyoprora (forests of Peru)

Footnotes – Antivenoms available from corresponding antivenom providers may be found in Appendix D

***Reference: Campbell and Lamar 1993**
**** Additional information on venomous snakes is available on AFMIC's MEDIC CD-ROM**

Appendix D: Sources of Snake Antivenoms*

Argentina - 1
Instituto Nacional de MicrobiologRa
"Dr. Carlos G. Malbran"
Av. Velez Sarsfield 563
Buenos Aires, Argentina

Brazil – 2
FundaHno Ezequiel Dias
Rua Conde Pereira
80-Gameleira 30550
Belo Horizonte-MG Brazil
TEL: (031) 332-2077
FAX: (031) 332-2534
TELEX: 392417 FEDS BR

Brazil – 3
Institutos Vital Brazil S.A.
Caixa Postal 28
Niteroi, Rio de Janeiro, Brazil
TEL: 55212558688

Brazil - 4
Instituto Butantan
Av. Dr. Vital Brazil, 1500
Caixa Postal 65
CEP 01051
Sno Paulo, SP, Brazil
FAX: (011) 815-1505
TELEX: (011) 83325 BUTA BR

Colombia - 5
Instituto Nacional de Salud
Av. Eldorado con Carrera 50, Zona 6
Bogot<, Colombia
FAX: 57-1-2220975
TEL: 57-1-2220577, ext. 147

Costa Rica - 6
Instituto Clodomiro Picado
Universidad de Costa Rica
Ciudad Universitaria "Rodrigo Facio"
San JosJ, Costa Rica
FAX: (506) 29-31-35
TEL: (506) 29-03-44

Ecuador - 7
Instituto Nacional de Higiene y
Medicina Tropical
"Leopoldo Izquieta PJrez"
Casilla Postal 3961
Guayaquil, Ecuador

Mexico – 8
Zapata Laboratories
Mexico City, Mexico
TEL: 592-82-70
TEL: 561-12-11
TEL: 592-88-93

Pennsylvania, U.S.A. – 9
Wyeth International Ltd.
P.O. Box 8299
Philadelphia, PA 19101-1245
TEL: (215) 688-4400

Peru - 10
Instituto Nacional de Hygiene
Lima, Peru

Peru – 11
Institutos Nacionales de Salud
Departamento de Animales Venenosos
Calle Capac Yupanqui 1400
Apartado 451
Lima, Peru
TEL: (51) 14416141
TEL: (51) 14678212
TEL: (51) 14311130

***Additional information on antivenoms is available on AFMIC's MEDIC CD-ROM**

Appendix E: Plants of Peru that Cause Contact Dermatitis*

Agave spp. (sap of leaves - saponin)
Ammannia spp., aquatic plant
Anacardium occidentale, cashew nut (nut, bark, leaves - anacardic acid)
Calophyllum inophyllum, lagarto caspi
Caloptropis spp., found in dry open areas, milkweed (milky sap)
Comocladia spp.
Croton spp., sangre de grado (resinous oil)
Dalechampia spp., vines in disturbed areas, manicillo
Daphne spp. (sap - mezerein)
Euphorbia spp. (sap - euphorbin)
Hippomane mancinella (milky latex and fruit)
Hura spp., tronador, sandbox, catahua (sap)
Malpighia spp., found in dry deciduous forests
Mangifera spp. (sap and green fruits)
Ricinus spp., castor bean (dust of seeds)
Schinus spp., found in inter-Andean valleys
Sterculia spp., huarmi caspi
Taxus spp., yew (fruit)
Thevetia peruviana, found in inter-Andean valleys (seeds, leaves, stems and roots)
Toxicodendron spp., found in middle elevation forests, itil, incati, maico, poison oak/ivy (seeds, leaves, and bark)
Urera spp., ishanga, mara mara, urticating nettle

***Additional information on vegetation is available on AFMIC's MEDIC CD-ROM**

Appendix F: Plants of Peru that are Toxic when Ingested*

Abrus spp., a woody liana (seeds and roots - sea level-300 m)
Ageratina altissima
Anacardium occidentale, cashew nut (nut and shell - anacardic acid)
Brugmansia spp., tree-like (seeds)
Calophyllum inophyllum, lagarto caspi, tornillon
Caloptropis spp., found in dry open areas, milkweed
Citrullus spp.
Conium maculatum (seeds, leaves, and roots)
Coriaria spp. (small fruits - corianmyratine)
Crotalaria spp. (seeds)
Croton spp., sangre de grado
Daphne spp. (bark, leaves, flower, fruit)
Datura spp. (seeds-scopolamine and hyoscyamine)
Dioscorea bulbifera (bulbs, if eaten uncooked)
Duranta spp., woody herbs in dry areas
Euphorbia spp. (sap and seeds)
Heliotropium spp., heliotrope
Hippomane mancinella (milky latex and fruit)
Hura spp., tronador, sanbox, catahua, manihot, yuca (sap, seeds and bark)
Jatropha spp. (seeds)
Manihot esculenta (uncooked roots - hydrocyanic acid)
Nerium oleander (leaves)
Phytolacca spp., airambo
Pilocarpus spp. (pilocarpine nitrate poisoning)
Ricinus spp., castor bean (seeds, leaves and stems)
Sapium spp., guta percha (sap)
Schinus spp., found in inter-Andean valleys
Solandra spp., found in cloud forests and lowland wet forests
Solanum spp., siucahuito, coconillo, cocona, tintona (fruits and leaves)
Strychnos spp., canopy lianas (contains curare alkaloids)
Taxus spp., yew (fruit)
Thevetia peruviana, found in inter-Andean valleys (seeds, leaves, stems and roots)
Toxicodendron spp., found in middle elevation forests, itil, incati, maico, poison oak/ivy (seeds, leaves, and bark)

***Additional information on vegetation is available on AFMIC's MEDIC CD-ROM**

Appendix G: Selected List of Identification Keys

Argasidae/Ixodidae

Fairchild, G.V., G.M. Kohls and V.J. Tipton. 1966. The Ticks of Panama (Acarina: Ixodoidea), pp. 167-219. *In*: R.L. Wenzel and V.J. Tipton (Eds.), Ectoparasites of Panama. Field Museum of Natural History, Chicago.

Jones, E. K., and C. M. Clifford. 1972. The Systematics of the Subfamily Ornithodorinae (Acarina: Argasidae). V. A Revised Key to Larval Argasidae of the Western Hemisphere and Description of Seven New Species of *Ornithodoros*. Ann. Entomol. Soc. Am., 65(3): 730-40.

Jones, E.K., C.M. Clifford, J.E. Keirans and G.M. Kohls. 1972. The Ticks of Venezuela (Acarina: Ixodoidea) with a Key to the Species of *Amblyomma* in the Western Hemisphere. Brigham Young Univ. Sci. Bull., Biol. Ser., 17(4): 1-40.

Keirans, J.E., H. Hoogstraal and C.M. Clifford. 1979. Observations on the Subgenus *Argas* (Ixodoidea: Argasidae: *Argas*). 16. *Argas* (*A.*) *moreli*, New Species, and Keys to Neotropical Species of the Subgenus. J. Med. Entomol., 15(3): 246-52.

Culicidae

Arnell, J.H. 1973. Mosquito Studies (Diptera, Culicidae). XXXII. A Revision of the Genus *Haemagogus*. Contrib. Am. Entomol. Inst., 10(2): 1-174.

Dodge, H.R. 1962. Supergeneric Groups of Mosquitoes. Mosquito News, 22(4): 365-68.

Faran, M.E. 1980. Mosquito Studies (Diptera, Culicidae) XXXIV. A Revision of the Albimanus Section of the Subgenus *Nyssorhynchus* of *Anopheles*. Contrib. Am. Entomol. Inst., 15(7): 1-215.

Faran, M.E. and K.J. Linthicum. 1981. A Handbook of the Amazonian Species of *Anopheles* (*Nyssorhynchus*) (Diptera: Culicidae). Mosq. Syst., 13(1): 1-81.

Gorham, J.R., C.J. Stojanovich and H.G. Scott. 1973. Illustrated Key to the Anopheline Mosquitoes of Western South America. Mosq. Syst., 5: 97-123.

Lane, J. 1953. Neotropical Culicidae. Volumes I & II, Sno Paulo, Univ. Sno Paulo.

Levi-Castillo, R. 1951. Los Mosquitos del Genero *Haemagogus* Williston, 1896 en America del sur. Editorial "Don Bosco," Cuenca, Ecuador, 76 pp.

Linthicum, K.J. 1988. A Revision of the *Argyritarsis* Section of the Subgenus *Nyssorhynchus* of *Anopheles*. Mosq. Syst., 20(2): 98-271.

Pecor, J.E., V.L. Mallampalli, R.E. Harbach and E.L. Peyton. 1992. Catalog and Illustrated Review of the Subgenus *Melanoconion* of *Culex* (Diptera: Culicidae). Contrib. Am. Entomol. Inst., 27: 1-228.

Sirivanakarn, S. 1982(1983). A Review of the Systematics and Proposed Scheme of Internal Classification of the New World Subgenus *Melanoconion* of *Culex* (Diptera: Culicidae). Mosq. Syst., 14(4): 265-333.

Zavortink, J.J. 1970. Mosquito Studies (Diptera, Culicidae) XIX. The Treehole *Anopheles* of the New World. Contrib. Am. Entomol. Inst., 5(2): 135.

Zavortink, J.J. 1973. Mosquito Studies (Diptera, Culicidae) XXIX. A Review of the Subgenus *Kerteszia* of *Anopheles*. Contrib. Am. Entomol. Inst., 9(3): 1-54.

Mammalia

DeBlase, A.F. and R.E. Martin. 1974. A Manual of Mammalogy, with Keys to Families of the World. Wm. C. Brown Company Publishers, Dubuque, Iowa, 329 pp. (Mammal trapping and ectoparasite collecting techniques, study skin preparations, and keys to family level)

Eisenberg, J.F. 1989. Mammals of the Neotropics, the Northern Cone. Vol. 1, Panama, Colombia, Venezuela, Guyana, Suriname, French Guiana. Univ. Chicago Press, Chicago, 449 pp. (Generic keys and index to common names)

Emmons, L.H. and F. Feer. 1997. Neotropical Rainforest Mammals, A Field Guide, 2nd Edition, Univ. Chicago Press, Chicago, 307 pp. (Family and generic keys – excellent detailed color illustrations of many species)

Fisler, G.F. 1970. Keys to Identification of the Orders and Families of Living Mammals of the World. Los Angeles County Museum of Natural History, Science Series, 25(2): 1-29. (Order and family keys)

Lawlor, T.E. 1976. Handbook of the Orders and Families of Living Mammals. MAD River Press, Eureka, California, 244 pp.

Plants

Gentry, A.H. 1993. A Field Guide to the Families and Genera of Woody Plants of Northwest South America (Colombia, Ecuador, Peru) with Supplementary Notes on Herbaceous Taxa, Univ. Chicago Press, Chicago, 895 pp.

Psychodidae

Young, D.G. and M.A. Duncan. 1994. Guide to the Identification and Geographic Distribution of *Lutozomyia* Sand Flies in Mexico, the West Indies, Central and South America (Diptera: Psychodidae). Mem. Am. Entomol. Inst. No. 54, 881 pp.

Reduviidae

Lent, H., and P. Wygodzinsky. 1979. Revision of the Triatominae (Hemiptera, Reduviidae) and Their Significance as Vectors of Chagas' Disease. Bull. Am. Mus. Nat. Hist., 163(3): pp. 125-520.

Simuliidae

Coscarón, S. 1987. El Género *Simulium* Latreille en la Región Neotropical: Análisis de los Grupos Supraespecíficos, Especies que los Integran y Distributión Geográfica (Simuliidae, Diptera). Museu Paraense Emílio Goeldi, Belém, Brazil. 112 pp. (In Spanish).

Coscarón, S. 1991. Simuliidae. Fauna de Agua Dulce de la Republica Argentina. 38. (Insecta, Diptera, Simuliidae), Fascicle 2, 304 pp. +78 pp. of unnumbered figures (In Spanish).

Coscarón, S. and P. Wygodzinsky. 1972. Taxonomy and Distribution of the Blackfly Subgenus *Simulium* (*Pternaspatha*) Enderlein (Simuliidae, Diptera, Insecta). Bull. Am. Mus. Nat. Hist., 147: 199-240.

Shelley, A.J., M. Arzube and C.A. Couch. 1989. The Simuliidae (Diptera) of the Santiago Onchocerciasis Focus of Ecuador. Bull. Br. Mus. (Nat. Hist.) Entomol., 58(1): 79-130.

Shelley, A.J., C.A. Lowry, M. Maia-Herzog, A.P.A. Luna Dias and M.A.P. Moraes. 1997. Biosystematic Studies on the Simuliidae (Diptera) of the Amazonia Onchocerciasis Focus. Bull. Br. Mus. (Nat. Hist.) Entomol., 66(1) 1-121.

Siphonaptera

Hopkins, G.H.E. and M. Rothschild. 1953. An Illustrated Catalogue of the Rothschild Collection of Fleas (Siphonaptera) in the British Museum (Natural History). I. Tungidae and Pulicidae. British Museum (Natural History), London, 361 pp. + 45 plates.

Johnson, P.T. 1957. A Classification of the Siphonaptera of South America. Mem. Ent. Soc. Wash. No. 5., Entomological Society of Washington, Washington, DC. 298 pp.

Smit, F.G.A.M. 1987. An Illustrated Catalogue of the Rothschild Collection of Fleas (Siphonaptera) in the British Museum (Natural History). Volume VII. Malacopsyllidae and Rhopalopsyllidae. Oxford University Press, London, 380 pp. + 5 plates.

Snakes

Peters, J.A. 1972. The Snakes of Ecuador, A Checklist and Key. Bull., Mus. Comp. Zool., 122(9): 491-541.

Tabanidae

Coscaron, S. and N. Papavero. 1993. An Illustrated Manual for the Identification of the Neotropical Genera and Subgenera of Tabanidae (Diptera). Museu Paraense Emilio Goeldi, Belem. 150 pp.

Fairchild, G.B. 1969. Notes on Neotropical Tabanidae XII. Classification and Distribution, with Keys to Genera and Subgenera. Arquivos de Zoologia., Sno Paulo, 17(4): 199-255.

Fairchild, G.B. and J.F. Burger. 1994. A Catalog of the Tabanidae (Diptera) of the Americas South of the United States. Mem. Am. Entomol. Inst. No. 55, 249 pp.

Wilkerson, R.C. and G.B. Fairchild. 1984. A Checklist and Generic Key to the Tabanidae (Diptera) of Peru with Special Reference to Tambopata Reserved Zone, Madre de Dios. Revista Peruana de Entomologia, 27: 37-53.

Trombiculidae

Brennan, J.M. and M.L. Goff. 1977. Keys to the Genera of Chiggers of the Western Hemisphere (Acarina: Trombiculidae). J. Parasitol., 63(3): 554-66.

Appendix H: Personal Protective Measures

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

1. **Grasp the tick's mouthparts** where they enter the skin, using pointed tweezers.

2. **Pull out** slowly and steadily with gentle force.

   a. Pull in the reverse of the direction in which the mouthparts are inserted, as you would for a splinter.

   b. **Be patient –** The long, central mouthpart (called the hypostome) is inserted in the skin. It is covered with sharp barbs, sometimes making removal difficult and time consuming.

   c. Many hard ticks secrete a cement-like substance during feeding. This material helps secure their mouthparts firmly in the flesh and adds to the difficulty of removal.

   d. It is important to continue to pull steadily until the tick can be eased out of the skin.

   e. **Do not** pull back sharply, as this may tear the mouthparts from the body of the tick, leaving them embedded in the skin. If this happens, don't panic. Embedded mouthparts are comparable to having a splinter in your skin. However, to prevent secondary infection, it is best to remove them. Seek medical assistance if necessary.

   f. **Do not** squeeze or crush the body of the tick because this may force infective body fluids through the mouthparts and into the wound.

   g. **Do not** apply substances like petroleum jelly, fingernail polish remover, repellents, pesticides, or a lighted match to the tick while it is attached. These materials are either ineffective or, worse, may agitate the tick and cause it to salivate or regurgitate infective fluid into the wound site.

h. If tweezers are not available, grasp the tick's mouthparts between your fingernails, and remove the tick carefully by hand. Be sure to wash you hands -- especially under your fingernails -- to prevent possible contamination by infective material from the tick.

3. Following removal of the tick, **wash the wound** (and your hands) with soap and water and **apply an antiseptic**.

4. **Save the tick** in a jar, vial, small plastic bag, or other container for identification should you later develop disease symptoms. Preserve the tick by either adding some alcohol to the jar or by keeping it in a freezer. Storing a tick in water will not preserve it. Identification of the tick will help the physician's diagnosis and treatment, since many tick-borne diseases are transmitted only by certain species.

5. **Discard** the tick after one month; all known tick-borne diseases will generally display symptoms within this time period.

Newly developed repellents provide military personnel with unprecedented levels of protection. An aerosol formulation of permethrin (NSN 6840-01-278-1336) can be applied to the uniform according to label directions, but not to the skin. This will impart both repellent and insecticidal properties to the uniform material that will be retained through numerous washings. An extended formulation lotion of N,N-diethyl-m-toluamide (deet) (NSN 6840-01-284-3982) has been developed to replace the 2 oz. bottles of 75% deet in alcohol. This lotion contains 33% active ingredient. It is less irritating to the skin, has less odor and is generally more acceptable to the user. A properly worn Battle Dress Uniform (BDU) impregnated with permethrin, combined with use of extended duration deet on exposed skin, has been demonstrated to provide nearly 100% protection against a variety of blood-sucking arthropods. This dual strategy is termed the DoD INSECT REPELLENT SYSTEM. In addition, permethrin may be applied to bednets, tents, and other field items as appropriate. Complete details regarding these and other personal protective measures are provided in TIM 36, *Personal Protective Techniques Against Insects and Other Arthropods of Military Significance* (1996).

Appendix I: Points of Contact for Peru

Commander
Navy Medical Research Institute Detachment
Lima, Peru
APO AA 34031-008
Telephone: 011-51-14-52-9662
Fax: 011-51-14-52-1560

U.S. Embassy
Avenida La Encalada, Block Seventeen
Lima, Peru
Country/City Code: 011-51-1
Telephones: 434-3000/434-3032

U.S. Embassy
Consular Agency
Avenida Tullumayo 125
Cuzco, Peru
Country/City Code: 011-51-8
Telephone: 424-5102
Internet: usconagt@qenco.rcp.net.pe

Dr. Elmer Escobar
Representante de la OPS/OMS en el Peru
Oficina Sanitaria Panamericana
Los Cedros 269, San Isidro
Lima 27, Peru
Country/City Code: 011-51-1
Telephones: 421-3030/442-4751
Fax: 442-4634

Dr. George A.O. Alleyne, Director
Pan American Health Organization
Pan American Sanitary Bureau
Regional Office of the WHO
525 Twenty Third Street, N.W.
Washington, DC 20037
Country/City Code: 202
Telephone: 974-3000
Fax: 974-3663