Office of the Deputy Under Secretary of Defense for Environmental Security

Disease Vector Ecology Profile

Ecuador

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

Homepage: http://www.afpmb.org

Revised December 1998

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.

Acknowledgments: The initial draft of this DVEP was prepared by Mr. Michael W. Hastriter, LTC, U.S. Army (retired). Subsequent technical reviews and emendations were provided by DPMIAC's COL Phillip G. Lawyer, Capt(Sel) Daniel J. Mauer, Dr. Richard G. Robbins and CDR George W. Schultz, as well as by LTC Daniel A. Strickman, Walter Reed Biosystematics Unit. The cover design and layout are the work of CDR Jeffrey A. Corneil and Mr. J. Rees Stevenson, both of DPMIAC.

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I. Executive Summary

Ecuador can be divided into three geographic regions: 1) **Costa** (coastal plains, sea level to 500 m, temperatures fluctuate from 18° to 32°C); 2) **Sierra** (Andean central highland plateau, 2,500-3,000 m between the Cordillera Occidental and the Cordillera Central, whose peaks may rise as much as 6,300 m, temperatures fluctuate from 3° to 31°C); and 3) **Oriente**, an undulating, sparsely populated tropical rainforest that drains into the Amazon Basin, temperatures fluctuate from 23° to 27°C). Rainfall is heavy in the northern Costa and Oriente, but scanty near the Peruvian border and in the Sierras. The rainy season is January-April.

Malaria, transmitted by the bite of infected *Anopheles* mosquitoes, is endemic countrywide, year-round below 2,000 m. Increased risk exists in northern lowlands on each side of the Andes. Quito and populated centers of the Sierras are not at risk. Annual numbers of cases have declined since 1990. Two thirds of the cases are in the coastal provinces of Manabi (70% *Plasmodium falciparum*), Guayas, and Esmeraldas. Chloroquine resistant *P. falciparum* occurs countrywide. 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 infective *Aedes aegypti* mosquito. Risk is year-round and elevated from December to May, especially in coastal urban areas. Outbreaks occurred in 1994 in Loja, Guayas, and Esmeraldas Provinces. Individuals who are serologically positive for the dengue virus are in greater danger of developing the more serious dengue hemorrhagic fever/dengue shock syndrome (DHF/DSS), if infected a second time. Sylvatic **yellow fever**, also a mosquito-borne viral disease, occurs focally east of the Andes, with low risk in urban areas. Highest risk is December to May. Eliminate larval breeding sources (artificial containers), spray interiors of tentage with permethrin, use **PPM** against mosquitoes, and use yellow fever vaccine.

Venezuelan equine encephalitis (VEE), **Eastern equine encephalitis** (EEE), **St. Louis encephalitis** (SLE), and **Western equine encephalitis** (WEE) each a mosquito-borne disease, have been reported in Ecuador. VEE was reported in southeastern Ecuador in early 1995 and VEE and EEE occur infrequently in the coastal lowlands and lowlands east of the Andes. These viruses do not occur in the Sierra region. Other poorly understood arboviruses occur in the eastern lowlands. Implement **PPM** against mosquitoes and biting flies.

Leishmaniasis is a protozoan disease transmitted in the New World by sand flies in the genus *Lutzomyia*. Most cases occur in the tropical and subtropical humid forests of the Pacific lowlands and western Andean foothills of Imbabura, Esmeraldas, Guayas, Los Rios, Manabi and Pichincha Provinces. Risk is year-round but greater during the rainy and early dry seasons below 2,000 m. Most cases occur below 1,000 m, particularly in Imbabura and Pichincha Provinces. From the middle 1980's to 1990, annual cases increased from 1,000 to 3,000 (90% cutaneous, 10% mucocutaneous). Sand flies bite primarily during twilight hours and after dark, although they will bite during the day if disturbed while in their resting habitats. Because sand flies have very short flight ranges, barrier and area control with residual insecticides is very effective. Avoid bivouacking in densely forested areas or close to human habitations, and use **PPM**, especially from sunset to sunrise.

Chagas disease is transmitted in infected feces of kissing bugs associated with substandard housing (e.g., thatch and adobe construction) prevalent in urban slums and rural areas. The disease is widely distributed, with elevated risk in the coastal provinces of El Oro, Guayas, Los Rios and Manabi and the montane provinces of Loja and Pichincha. Bivouac away from domestic and peridomestic settings. Use **PPM** to protect against kissing bugs.

Relapsing fever (louse-borne) and **Epidemic typhus** (louse-borne) are endemic countrywide but particularly in elevated cooler areas of the Andes from March to September. Both diseases proliferate during crowded and unsanitary conditions. Avoid contact with local populations.

Rocky Mountain spotted fever is a rickettsial disease transmitted by the bite of infected ticks. Use **PPM**, check for ticks frequently, and remove attached ticks promptly.

Murine typhus is transmitted in infected feces of biting fleas. Avoid areas infested by commensal rodents and use **PPM** against fleas.

Relapsing fever (tick-borne) is focally endemic at low levels. Do not bivouac in local substandard housing. Use **PPM** to prevent soft-bodied *Ornithodoros* ticks from biting.

Plague, transmitted by the bites of fleas, has not been reported since 1985; however, extensive outbreaks in neighboring Peru occurred in 1992-94. Avoid rodent-infested areas and use **PPM**.

Bartonellosis is a bacterial disease transmitted by sand flies in coastal provinces <800 m in elevation and in the valleys of the Sierras. Control sand flies and use **PPM** against them.

Leptospirosis is contracted when broken skin or mucous membranes come into contact with infected rodent urine/feces via contaminated surfaces, food, or water. Avoid rodent-infested habitats, bathing in potentially contaminated water, and drinking untreated water.

Onchocerciasis, a filarial worm transmitted by black flies, is prevalent along rivers in Esmeraldas Province, with foci south along the coastal plain. Vector populations peak from December through April. Use **PPM** against black flies.

Rabies, transmitted by the bite of rabid vampire bats, is a serious threat in Zamora-Chinchipe Province, where 8 human fatalities were reported in May and June 1997. Personnel suspected of having been bitten by vampire bats should report immediately for medical treatment.

Venomous snakes, poisonous arthropods, and plants that are poisonous to ingest or cause contact dermatitis are present throughout Ecuador. Ticks, fleas and chiggers are causes of significant discomfort. Severe irritation and scratching may result in secondary infections. Apply residual pesticides to bivouac areas and use **PPM** against ticks, chiggers and fleas. Teach troops to recognize and avoid contact with poisonous plants.

II. Map of Ecuador (CIA)

III. Country Profile

A. Geography. The Republic of Ecuador is located on the northwest coast of South America and is situated on the equator, from which it derives its name. It is the third smallest state in South America, after Uruguay and Guyana. Slightly smaller than Nevada, Ecuador has a total land area of 283,560 km^2 (109,454 mi^2) and is bordered on the north by Colombia (590 km/366 mi), on the south and east by Peru (1,420 km/880 mi), and on the west by the Pacific Ocean (2,237 km/1,387 mi). The boundary with Peru has never been accepted by Ecuador, which claims a larger portion of the Amazon Basin. The country is divided into 17 provinces. The Andean mountain ranges running parallel north and south create three distinct topographical regions: 1) The Costa, or coastal lowlands, vary in width from 25 km (15 miles) to 200 km (125 miles) and rise from sea level to about 500 m (1,600 ft). In the center of these lowlands, a small mountain range rises to 800 m (2,600 ft), separating an inland undulating valley from the coastline. Three rivers run south through the valley (Rio Daule, Rio Vinces, and Rio Babahoyo) and empty into the Gulf of Guayaquil at the port city of Guayaquil. To the north in Esmeraldas Province, several small rivers join forming the Rio Esmeraldas, which runs northward emptying into the Pacific Ocean at the port city of Esmeraldas. This northern area drainage has a warm rainy climate with two wet seasons, while the southern region has a rainy season from January to May and a dry season that increases toward the south. The Costa comprises 17% of Ecuador's land area. 2) The Sierra, a platform in the Andean central highlands (2,500-3,000 m/8,000-10,000 ft), lies between the Cordillera Occidental and the Cordillera Oriental. This plateau is subject to severe earthquakes and is studded with 22 volcanoes, the highest rising to 6,270 m (20,577 ft). The Sierra occupies about 24% of Ecuador. 3) The Oriente, an undulating expanse of tropical rain forest, lies east of the Andes Mountains. Numerous tributaries drain the eastern slope of the Andes into the headwaters of the Amazon, subjecting the area to severe flooding from January to April. The major rivers of the region include the Rio Napo and the Rio Pastaza. The Oriente comprises approximately 59% of the country. Little is known about the medically important arthropods of the Oriente.

B. Climate. Ecuador may be divided into three climatic regions: 1) the Tierra Caliente (hot land), sea level to approximately 900 m (3,000 ft), has average temperatures of 24°-26°C (75°-79°F); 2) the Tierra Templada (temperate land), 900-2,000 m (3,000-6,500 ft), has average temperatures of 18°-24°C (64°-75°F); and 3) the Tierra Fria (cold land), 2,000-3,000 m (6,500-10,000 ft), has average temperatures of 13°-18°C (55°-64°F). The wet season runs from October through March. The lower limit of permanent snow occurs at about 4,500 m (14,760 ft). Temperatures and rainfall are relatively constant year-round in the lowlands east of the Andes [23°-27°C (73°-81°F) and up to 600 cm (40 inches) per year]. Guayaquil (Table 1) is representative of the coastal climate, with a rainy season from December to April. Toward the north, the annual rainfall increases to as much as 2,000 mm (80 inches); to the south it decreases to as little as 200 mm (8 inches). Temperatures vary 2°C or less, both day and night throughout the year, with day and night fluctuations ranging from 9° to 12°C (16° to 22°F). Quito (Table 2) is climatically representative of the Cordillera Occidental and Oriental, where daytime temperatures are spring-like throughout the year and night temperatures are 14°-16°C (25°-29°F) cooler.

Table 1. 3-year meteorological summary for Guayaquil (6 m/20 ft).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Highest Temp. (°C)	36	34	33	34	35	34	33	33	34	34	34	37
Av. Maximum (°C)	31	31	31	32	31	31	29	30	31	30	31	31
Av. Minimum (°C)	21	22	22	22	20	20	19	18	19	20	20	21
Lowest Temp. (°C)	19	19	18	21	18	18	17	17	14	17	16	19
Av. Rainfall (mm)	239	249	277	117	28	8	5	0	3	8	3	51

Table 2. 13-year meteorological summary for Quito (2,879 m/9,446 ft).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Highest Temp. (°C)	26	27	27	26	26	26	26	28	28	30	27	27
Av. Maximum (°C)	22	22	22	21	21	22	22	23	23	22	22	22
Av. Minimum (°C)	8	8	8	8	8	7	7	7	7	8	7	8
Lowest Temp. (°C)	3	1	4	4	2	2	1	2	2	0	1	1
Av. Rainfall (mm)	99	112	142	175	137	43	20	31	69	112	97	79

C. Population/People. Approximately 96% of Ecuador's 12,105,124 (July 1997 estimate) people are concentrated on the Costa (ca. 49%) and in the Sierra (ca. 47%), leaving the Oriente sparsely populated. Sixty percent of the population lives in urban areas and countrywide, there are 43 persons/km2 (111 /mi^2). Ninety percent of the population is Roman Catholic. Fifty-five percent of Ecuador's population is Mestizo (mixed Indian and Spanish), 25% Indian, 10% Spanish, and 10% Black. The official languages are Spanish and various Indian dialects (especially Quechua).

D. Living and Sanitary Conditions. Countrywide, approximately 70% of the urban population and less than 10% of the rural population have access to sewage connections. Septic tanks and pit latrines are widely used. Although a central sewage system services Quito, untreated sewage empties directly into ditches leading to waterways. Urban areas have regular refuse collection, but refuse management is poor. Indiscriminate disposal occurs in some rural areas. Rural homes usually are one-room huts, with thick adobe walls, earthen floors, and roofs of tile, wood, thatch, or metal.

1. Pollution: Water pollution caused by sewage, deforestation, overgrazing, and intensive land use is Ecuador's major environmental problem. More than 95% of the forests along the Costa have been cut down. The Sierra already is nearly completely devoid of natural forest cover. Consequent soil erosion, flooding, devegetation and desertification seriously threaten Ecuador's watershed. Improper mining practices in the Costa and oil spills in the Oriente also contribute to soil and water pollution. Heavy metals, such as mercury, lead, zinc, copper and cadmium, are discharged into rivers that supply drinking water for the towns of Santa Rosa, La Avanzada, Arenillas, and Machala. Rapidly growing urban populations do not have the capability to adequately treat all sewage. Excessive use of pesticides has contributed to pollution in the Gulf of Guayaquil. Although extreme air pollution has not been reported, the use of poor quality diesel fuel is increasing air pollution in urban areas.

2. Water: Wells account for approximately 50% of the water supply in the Costa, springs account for about 80% of the supply in the Sierra, and surface waters account for 60% of the supply in the Oriente. Drilled wells are frequently subject to electrical and mechanical difficulties. Old and poorly maintained water treatment and distribution systems provide irregular service, contributing to tap water contamination. Piped water is available to about 80% of the urban population.

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

A. Malaria. Malaria is a protozoan blood parasite transmitted to humans by the bite of infective *Anopheles* mosquitoes. Two of the four human malaria species occur in Ecuador: *Plasmodium falciparum* and *Plasmodium vivax*. *Plasmodium falciparum* (malignant tertian), the most serious of the four malarias, frequently causes death (10% in untreated non-immune adults). *Plasmodium vivax* (benign tertian) is 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 the initial clinical disease. Consequently, relapses producing clinical malaria may occur months to years later. 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* 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 fever subsides for a period and is followed by subsequent cycles of fever, chills, and sweating.

1. Military Impact and Historical Perspective. There has been a decrease in the number of cases of malaria since its peak in 1990 (from 71,670 in 1990 to 30,000 in 1994). The provinces of Esmeraldas, Guayas and Manabi accounted for about 2/3 of the cases reported during 1993, and 70% of the cases from Manabi Province were *P. falciparum*. *Plasmodium falciparum* comprises about 30-40% of the malaria cases countrywide. Cases occur year-round with increased risk from February through August (rainy season and first half of dry season). Overall risk increases in northern Ecuador on both sides of the Andes below 2,000 m (6,400 ft). Historically, malaria afflicted up to 40% of some Army units in Vietnam. Commanders lost two of every five men for substantial periods of time, seriously compromising their missions. The threat in Ecuador is equally great, compounded by known *P. falciparum* resistance to chloroquine and vector resistance to pesticides. Malaria is largely preventable and casualties can be minimized with application of the measures outlined in paragraph IV.A.4.

2. Transmission Cycle. Humans are the sole reservoir for human malaria parasites (*P. vivax*, *P. falciparum*, *P. malariae* and *P. ovale*). 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 that occur with increased altitudes will increase the time for development. From the injection site, the sporozoites travel to the liver, where they invade the liver cells and divide, becoming asexual merozoites. After several division cycles, the merozoites leave the liver cells and parasitize individual red blood cells (RBCs). Most become schizonts that rupture the RBCs, causing the characteristic symptom of "fever and chills." Some of the merozoites develop into male and female gametocytes capable of infecting other *Anopheles* mosquitoes. Once infected, mosquitoes remain infective for life. Infected humans are potential reservoirs of infection as long as the sexual gametocytes are circulating in the blood. In vivax malaria, this is only 1-2 days after onset of symptoms as opposed to 10-12 days after onset in falciparum malaria.

3. Vector Ecology Profile. Important vectors of malaria in Ecuador are *An. albimanus*, *An. calderoni*, *An. darlingi*, *An. pseudopunctipennis*, *An. aquasalis*, and *An. trinkae*. Relative importance depends on seasonal and/or geographic distribution. Vector ecology profiles for these species are presented in Appendix A.1. Increasing knowledge of anopheline species in the Americas suggests the existence of complexes or sibling species. Populations previously recognized as *An. punctimacula* along areas of the Pacific coast are currently considered *An. calderoni*. A list of mosquitoes known to occur in Ecuador, and keys for identifying mosquitoes are presented in Appendices B.1 and G, respectively.

4. Vector Surveillance and Suppression. Larval and adult surveillance techniques are used 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 will provide data on species composition and population dynamics on which to base control measures. Adult surveillance of potential anopheline vectors principally includes collection on animal or human bait or collection of 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 using a mouth or powered aspirator and 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 population, reduction of *Anopheles* mosquito 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 window is reduced to less than 4 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 Ecuador, *P. falciparum* is resistant to chloroquine, and Fansidar resistance is indicated in neighboring Colombia. 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. Organophosphate resistance has been reported for *An. albimanus* in agricultural area of Guayas, Manabi, and Los Rios Provinces, but not in the province of Esmeraldas. *Anopheles albimanus, An. punctimacula* and *An. pseudopunctipennis* are reportedly resistant to DDT, Dieldrin and Lindane (various WHO reports). Resistance to pyrethroids is also reported for *An. albimanus* (WHO, 1992). **Personal Protective Measures** to prevent mosquito bites include minimizing exposed skin by wearing permethrin-treated BDUs with sleeves down (particularly after sunset), using extended-duration deet repellent, arthropod repellent deet jackets, 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 and 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 dengue virus.

1. Military Impact and Historical Perspective. A small outbreak of 25 cases (DEN-1) occurred in Ecuador from February through April 1988 in the area of Guayaquil (Los Rios and Guayas Provinces). Subsequent outbreaks of serotype 1 have continued to occur, (1990: 302 cases, 1992: 137 cases). DEN-1, 2 and 4 have been reported in the provinces of Loja, Guayas and Esmeraldas. Cases of DHF/DSS were reported in 1994 but not confirmed. The Epidemiology Department of the Ministry of Health registered fewer than 30,000 dengue fever cases between 1990-1996. Many dengue cases in the resident population, however, are never seen by medical professionals. High *Ae. aegypti* household indices are reported throughout the country below the altitudinal limits of the vector (2,000 m/6,560 ft). 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. When operating in endemic urban and peri-urban locations, it is essential to use personal protective measures to prevent 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 Ecuador, it occurs in Tabatinga, Brazil, approximately 687 km (425 mi) from the eastern border of Ecuador.

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 by 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 ultra-low-volume (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). Resistance to lambda-cyhalothrin also has been reported for this mosquito in cities countrywide in neighboring Colombia. The individual soldier can best prevent dengue fever by utilizing **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. The disease has largely been eliminated from urban areas. Yellow fever continues as focal enzootics and epizootics in the eastern areas of the Amazon River Basin (Napo, Morona-Santiago, Pastaza, Sucumbios, and Zamora Chinchipe Provinces) among native species of *Haemagogus* and *Sabethes* mosquitoes and a number of primate species. The yellow fever vaccine offers immunized soldiers essentially 100% protection; however, host country soldiers or allies may not have such 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 onset of fever to 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, monkeys being the amplifying hosts. 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 in 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 the amplifying host for the virus.

3. Vector Ecology Profile. *Aedes aegypti* is the primary vector of yellow fever in the urban mosquito-human transmission cycle. The vector ecology profile for *Ae. aegypti* is presented in Appendix A.2. *Haemagogus janthinomys* and *Sabethes chloropterus* are the vectors in the sylvatic cycle (human-mosquito-monkey) in Ecuador. The vector ecology profiles for these species are 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 the epidemiologies and potential for producing severe hemorrhagic disease. In general, other arboviral fevers in Ecuador are poorly understood; however, some have the potential for inflicting high morbidity, especially in non-immune personnel. Incapacitation can occur rapidly, lasting a few days to several weeks. Although clinical symptoms differ slightly for each, they generally consist of fever, headache, dizziness, arthralgia, myalgia, often a rash, and occasional prostration. Documented Ecuadorian arboviruses include the Togaviridae (Alphaviruses): Eastern equine encephalitis (EEE), Venezuelan equine encephalitis (VEE), Western equine encephalitis (WEE) and Flaviviridae (Flaviviruses): St. Louis encephalitis (SLE). Viruses that occur in Colombia and Peru that likely also occur in Ecuador (but are not documented) include the Togaviridae (Alphaviruses): Mayaro; Flaviviridae (Flaviviruses): Bussuquara, Ilheus; and Bunyaviridae (Bunyaviruses)**,** California Group: Guaroa, and Simbu Group: Oropouche. Arboviruses that occur in Ecuador, 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 those known in Ecuador) are included in the appendix. Vaccines are not available for these arboviral diseases. Prevention of human cases requires control of biting arthropods, use of repellents (day and night) and bed nets, and avoidance of forest habitats when possible.

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 considered 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 association with urban areas and rural villages, especially those near banana and cacao crops. U.S. military entomologists in Brazil noted that applications of insecticide in cacao and banana plantations for other agricultural pests drastically reduce 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 ample breeding 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 doing so while in the life zone of *C. paraensis* are at greater risk of being bitten. Do not camp in or adjacent to banana or cacao plantations.

2. Venezuelan Equine Encephalitis. Mosquitoes transmit the causative agent of sylvatic and epizootic VEE. Sylvatic VEE is a mild, low-level viremia in equines, while epizootic VEE kills most non-immunized equines and produces high viremias capable of infecting vector mosquitoes. Either form of VEE can produce severe disease, encephalitis, and death in humans. Human cases of VEE usually follow the beginning of an epizootic in horses by about two weeks. Nearly all genera of mosquitoes are capable of transmitting VEE, but *Aedes scapularis*, *Ae. aegypti*, *Aedes taeniorhynchus*, *Mansonia tillitans*, and *Deinocerites pseude*s 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. Human cases of VEE usually follow the beginning of an epizootic in equines by about two weeks. VEE activity, including human cases, was reported from southeastern Ecuador during early 1995. The likelihood of VEE occurring in troops during military operations is low unless an epizootic is occurring in equine populations, which greatly increases the risk. Sporadic cases of sylvatic VEE are possible in forested areas inhabited by species of *Culex* (*Melanoconion*) when virus is enzootic in rodent and bird populations. Sources for keys to the 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 world. This disease is caused by *Trypanosoma cruzi*, a flagellated protozoan 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 none to unilateral facial edema (Romaña'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 usually involve the heart, intestinal and autonomic nervous systems and persist for many years after the initial infection. 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 a method of 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. Chagas disease occurs countrywide in sylvatic animals, but more human cases occur in open savanna-like regions than in forested areas. Current endemic areas include the coastal provinces of Guayas, El Oro, Manabi and Los Rios, and the inter-Andean valleys of two montane provinces, Loja and Pichincha. East of the Andes, sylvatic foci were recently discovered in the lowland tropical forest areas of Sucumbios and Napo Provinces (6% of the population is positive for Chagas disease along the Rio Napo). The disease is undoubtedly found in similar habitats in the tropical lowlands south of Napo Province. Since soldiers operate in the forest, it is more likely they will be bitten by extradomiciliary kissing bugs, especially if they do not use personal protective measures. In addition, the disease has the potential to infect many troops that bivouac (sleep) adjacent to or in areas with substandard housing (e.g., makeshift and palm thatched construction). Avoid such areas and use personal protective measures to preclude biting bugs and minimize the 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 triatomines 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 so for life (as long as two years). Nymphal triatomines may also acquire trypanosomes while feeding on the infected blood of engorged bugs. All stages of the bug may become infective. Human infections occur when bugs defecate on the skin during feeding and the infected feces are rubbed into the bite puncture or abrasions, or onto the mucosae of the eye, 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 that have delayed patterns of defecation (e.g., 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 Ecuadorian species *Triatoma infestans*, *Triatoma dimidiata*, *Triatoma carrioni*, *Panstrongylus chinai*, *Rhodnius prolixus* and *Rhodnius ecuadoriensis* are presented in Appendix A.4.

4. Vector Surveillance and Suppression. Surveillance of triatomines is best conducted with the aid of a flashlight during hours of darkness. 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 and wood and thatched roofs, also should 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 beds will control bug populations. Deltamethrin has been used successfully for controlling *T. infestans* in domestic and peridomestic situations. Species of Reduviidae that occur in Ecuador appear in Appendix B.2. Risk of contacting vectors is greatest in or near dwellings with abundant cracks and crevices (e.g., thatch, dirt, or makeshift shanty construction) and domestic animal shelters (e.g., livestock, chickens, pigeons, etc.). Avoid sleeping near palm trees that may harbor triatomines, since sylvatic species are potential biters also. 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 also will exclude night-feeding triatomines (TIM 36).

F. Rocky Mountain Spotted Fever. *Rickettsia rickettsii*, the causative agent of RMSF, is transmitted to man by the bite of an infected tick. This febrile illness begins with sudden onset of fever, severe headache (frontal and occipital), chills, deep muscle pain, aching in the lumbar region, and malaise. The most characteristic and constant symptom is a maculopapular rash that begins on the extremities (wrists and ankles) on the 2nd or 3rd day and spreads to all parts of the body. The incubation period from tick bite to first symptoms ranges from 2 to 14 days. Fatalities occur in 3-5% of the cases between 9 and 15 days from onset. Early diagnosis and treatment are essential to ensure recovery.

1. Military Impact and Historical Perspective. Although case reports of RMSF in Ecuador could not be found, it is undoubtedly endemic, as it occurs in neighboring Colombia. The Colombian vector is common and ubiquitous throughout Ecuador, and the potential for contracting the disease through tick bites is comparable to that of endemic areas in the midwestern and eastern areas of the U.S. Follow the precautions for preventing tick bites (TIM 26 and TIM 36) and for proper removal of ticks (Appendix H).

2. Transmission Cycle. The rickettsial organism is maintained in the tick population primarily by transovarial and transstadial transmission. Dogs, small rodents and ungulates are potential reservoirs of *R. rickettsii*, but are considered to be of minor importance. All three stages of the tick (larva, nymph and adult) will readily feed on humans and each is capable of transmitting the agent during feeding. Ticks must feed for 4-6 hours before rickettsiae can be transmitted to the host. Ticks are infected for life (up to18 months).

3. Vector Ecology Profile. The principal vector of RMSF is the cayenne tick, *Amblyomma cajennense*. Experimental infection and transovarial and transstadial transmission also has been demonstrated in the soft tick *Ornithodoros parkeri*, implicating it as a potential vector of RMSF. Both sexes of *A. cajennense* are hematophagous, and females require a blood meal for oviposition. *Amblyomma cajennense* is a three-host tick with diverse host preferences. Larval and nymphal stages are found most frequently on small and intermediate-sized hosts (e.g., rodents, marsupials, etc.), while adults prefer larger mammals (ungulates). Questing behavior is similar to that of other three-host ixodid ticks. Larval and nymphal ticks quest on lower surfaces (e.g., grass, leaves, and twigs), while adults crawl to greater heights on tall grasses, bushes, and shrubs. Questing activity is particularly great during cool mornings and evenings when relative humidity is high in the ticks' questing zone. Questing is also greater following rain showers.

Tick populations are reduced in the dry season of June-August. Populations are typically higher in scrub areas with secondary growth, particularly along edges of forest clearings frequented by larger ungulates (deer).

4. Vector Surveillance and Suppression. Assessment of tick populations for species composition and population densities may be accomplished with tick drags and CO_2 baited traps. The former are made of white flannel cloth (30-40 inches square), either attached to a dowel for dragging or to a pole (as a flag) for waving over the surface of the ground or vegetation. Questing ticks will adhere to the flannel surface for easy collection. Simple CO_2 traps can be made with a piece of white material 3 to 4 feet square (non-flannel) laid on the ground with a block of dry ice placed in the center. Flannel material will impede the movement of ticks toward the dry ice. Place double-stick tape on the sheet 360° around the piece of dry ice to entrap ticks as they advance toward the CO_2. Ticks also may be found adhering to the underside of the cloth. Broad area tick control is usually not practical or necessary except in areas where personnel are concentrated (command posts, permanent bivouac areas, garrisons, etc.). Provide area tick control with formulations of chlorpyrifos in accordance with TIM 24. The best personal defense against ticks is the permethrin-impregnated BDU with trousers tucked into boots. Ticks can crawl under blousing garters. Use extended-duration deet skin repellent on exposed skin areas, especially on the back of neck at the hairline. Check for ticks frequently using the buddy system. Consult Appendix H for detailed guidelines on tick removal.

G. Epidemic Typhus. The agent of epidemic or louse-borne typhus, *Rickettsia prowazekii,* is transmitted in the feces of infected body lice (*Pediculus humanus humanus*) and not by the bite of the louse. Symptoms appear 7-14 days after infection, which include: headache, 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 focally endemic throughout the Andean cordilleras among Indian populations. Minor outbreaks were reported in Chimborazo and Bolivar Provinces during 1970. Historically, most cases occur between March and September. Data are scanty after the late 1970s, because the disease is no longer reportable. The potential for outbreaks among indigenous populations 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** (TIM 36). The Department of Defense no longer has the capability to mass delouse refugees, displaced persons, and other civilians using insecticidal dusts with powered application equipment.

Refugees, Displaced Persons and Other Civilians. 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. Current options will 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. humanus*. During the febrile period and for 2-3 days after, lice may acquire rickettsiae while feeding. Louse feces become infective 2-6 days thereafter. A 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 or 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 viable for no 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 seven 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 that result in concentration 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 suspect 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 or among prisoners of war includes 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.

H. 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. 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 may result in 2-10% of untreated cases.

1. Military Impact and Historical Perspective. Epidemiological information is unavailable, but limited enzootic foci likely exist where vector tick species occur, as in coastal river valleys and lowlands east of the Andes. It is unlikely that soldiers will be exposed to soft-bodied ticks; however, troops should avoid using potentially tick-infested dwellings of indigenous populations for shelter.

2. Transmission Cycle. The vector is the soft-bodied tick *Ornithodoros rudis*. Ticks and humans are the primary reservoirs. Rodents play a minor role as hosts since ticks feed on them only opportunistically. *Ornithodoros rudis* spends its life in primitive or makeshift habitations of humans in somewhat dry conditions. The spirochete invades the hemocoel, salivary glands, coxal glands, and ovaries within 3-4 days of feeding on an infected human (or, occasionally, rodents). Transovarial transmission of the spirochete occurs, but transmission is maintained mostly between humans and ticks. Once infected, ticks remain infective for life. Transmission occurs during 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 infested sites will eliminate ticks (TIM 24). Troops should avoid utilizing indigenous shelters or caves for overnight bivouac sites. Use **Personal Protective Measures** (TIM 36) when potential exposure cannot be avoided, particularly at night when *Ornithodoros* ticks feed.

I. Murine Typhus. *Rickettsia typhi* (formerly *R. mooseri*), the causative agent for murine typhus, is transmitted in the feces or crushed bodies of infected fleas. Symptoms appear 6-14 days from time of infection. The disease is similar to epidemic typhus, but symptoms are milder and fatalities are rare. Symptoms include headache, high fever, chills, prostration and general body aches. Untreated cases result in < 5% mortality, but complete recovery is expected when treated with antibiotics.

1. Military Impact and Historical Perspective. Murine typhus can be a serious debilitating illness. Recent evidence of murine typhus in Ecuador is lacking, but the disease may be endemic in localities where commensal rodents (*Rattus* spp.) are abundant, especially coastal urban areas. Occasional cases may be expected, but impact on operations should be negligible.

2. Transmission Cycle. Murine typhus is a domiciliary disease associated with commensal rats and their fleas. The reservoirs are *Rattus rattus* and *Rattus norvegicus*. The rickettsia is routinely transmitted between rodents by the fleas *Xenopsylla cheopis*, *Leptopsylla segnis*, *Nosopsyllus fasciatus* (occasionally), the louse *Polyplax spinulosa*, and the mite *Ornithonyssus bacoti*. Although all three species of fleas will bite man, only *X. cheopis* is considered important in transmission from rats to man. Rickettsial organisms are imbibed from an infected rat by *X. cheopis*, replicate in the epithelial cells of the midgut, escape into the midgut after 3-5 days, spread to the entire lining of the midgut within 7-9 days, and feces become infected by the 10th day. Fleas may continue to pass infected feces for 40 days. Although the primary mode of transmission is via infected feces, rickettsiae may be transmitted by the bite three weeks after the initial infection. Infected *X. cheopis* remain infective for life (5+ months). Unlike epidemic typhus, murine typhus rickettsiae do not kill the vectors, and their reservoir rodent hosts are also unaffected. During feeding, *X. cheopis* may pass infected feces onto the skin. These may be scratched or rubbed into the bite, abraded skin, or conjunctivae of the eyes and mucous membranes. Man is an accidental host and is not implicated in maintenance of the disease cycle. Endemic foci are generally found in urban areas but may be rural when commensal rodents are abundant.

3. Vector Ecology Profile. The major vector of murine typhus in Ecuador is *X. cheopis*, whose profile is presented in Appendix A.5 (included with plague vectors).

4. Vector Surveillance and Suppression. Evidence of commensal rodent populations includes the presence of burrows, rat runs and rub marks, droppings, and rodent damage. Rodent populations can be evaluated with snap traps or cage traps baited with local fruits, vegetables, or rolled oats/peanut butter mixtures. Discourage commensal rodents in permanent encampments by eliminating sources of food, shelter and water. Bury putresible wastes and garbage. If eradication is necessary, use rodenticides in accordance with guidelines (TIM 24 and TG 138). Wear permethrin-treated BDUs with trousers tucked into boots to protect against fleas. Fleas will crawl under blousing garters. Bivouac away from human habitations, sources of manmade rodent harborage, and agricultural grain harvest areas.

J. Relapsing Fever (louse-borne). The etiological agent of louse-borne epidemic relapsing fever, *Borrelia recurrentis*, is transmitted by the human body louse, *P. h. 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 relapsing fever likely occurs countrywide in human populations that are infested with body lice, particularly in mountain valleys where epidemic typhus is focally endemic. The disease will be of little military significance if precautions outlined under epidemic typhus, paragraph IV.G., are followed.

2. Transmission Cycle. The transmission cycle is similar to that of epidemic typhus. The disease is confined to the louse-human-louse cycle. 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 feces of the louse are not infected with spirochetes and spirochetes do not kill the louse (as rickettsiae do in epidemic typhus), nor are spirochetes transmitted through the bite. Transmission occurs only by rubbing infected haemolymph of a crushed louse into the bite or other abraded areas. Infective lice remain so for life (20-40 days).

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

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

K. 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 bacilli enter the blood stream, where it shortly disseminates to the lungs and causes pneumonic plague. 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% case fatality rate, while septicemic and pneumonic cases are usually fatal if not treated early.

1. Military Impact and Historical Perspective. A few cases of plague occur in Guayas and Manabi Provinces, but most outbreaks occur at higher elevations in the valleys of the Andes between the east and west Cordilleras. Chimborazo Province has historically been a highly endemic area, with cases also in the mountainous western region of Pastaza Province. The largest outbreak of plague in 50 years occurred in Peru in the northern departments bordering Ecuador in 1992-1994. Sylvatic plague is endemic in the southern provinces of Loja and Zamora-Chinchipe. The temperatures of the Andean valleys are optimal for urban plague, with monthly maximum temperatures below 24°C throughout the year. In the southern mountain areas, cases could be expected during the dryer seasons of May to December and in the central highlands (Chimborazo Province) during January to March. A vaccine is available that provides significant protection from the disease. Sporadic cases might be expected during operations conducted among urban populations where known cases have occurred or are occurring. Impact on operations would be minimal, with few cases expected.

2. Transmission Cycle. There are two cycles of plague: sylvatic and urban. Sylvatic plague is zoonotic in a wild rodent-flea cycle. Wild rodent reservoirs and their fleas usually perpetuate the plague cycle unnoticed in plague-endemic foci. Some rodents are refractory to the effects of plague, while others are susceptible, resulting in epizootics and die-offs of susceptible populations. When humans enter the domain of a sylvatic cycle, they become exposed to infected fleas. These cases are sporadic and focal. Urban plague occurs when domestic rodents come in contact with plague-infected sylvatic rodents and/or their fleas. The urban cycle 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. This causes the flea to aspirate back and forth repeatedly, effectively inoculating the plague bacilli, in 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. Sylvatic plague may occur at any time of the year.

3. Vector Ecology Profile. The primary vector of urban plague in Ecuador is the cosmopolitan 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 the vector potential of *P. irritans* in urban situations. *Polygenis litargus*, occurring on *Sciurus stramineus*, is also an incriminated sylvatic vector of plague in Ecuador. This arboreal tree squirrel, similar to North American tree squirrels, is an important reservoir along the Peru-Ecuador border (below ca. 3°S latitude). Vector ecology profiles for these fleas are presented in Appendix A.5. Ecuadorian fleas and keys for their identification appear in Appendices B.3 and G, respectively. Most of the sylvatic fleas in Ecuador are poorly studied for their capacity as vectors or reservoirs.

4. Vector Surveillance and Suppression. Basic surveillance requires trapping rodents, collecting fleas, identifying the fleas and calculating the average number 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 existence of 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. 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 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 plague transmission by causing plague-infected fleas to seek new hosts. Carbamates such as carbaryl are effective and relatively safe pesticides for flea control. *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 protozoan parasites in the genus *Leishmania* 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. 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," while *L. chagasi*, which has not been reported in Ecuador, produces life-threatening VL. Leishmaniasis is endemic in all three major geographic regions of the country. At least six *Leishmania* species been reported in country wide. These include *Leishmania amzonensis, L. braziliensis, L. equatorensis, L. guyanensis, L. mexicana*, and *L. panamensis*.

1. Military Impact and Historical Perspective. From the middle 1980s to 1990, the annual number of cases rose from about 1,000 to 3,000 nationally. More than 90% of confirmed cases were of the cutaneous variety and the remainder mucocutaneous (VL has never been confirmed in Ecuador). A 1991 report indicates leishmaniasis is endemic in 14 of the 20 provinces. Most cases have occurred in tropical and subtropical humid forests of the Pacific lowlands and western slopes of the Andes (Esmeraldas, Pichincha, Manabi, Los Rios and Guayas Provinces). The potential for many cases of leishmaniasis (CL and MCL) is great in these regions. Endemic eastern lowland areas of Napo, Pastaza, and Morona-Santiago Provinces are sparsely populated, and current epidemiological information for leishmaniasis is lacking. Intrusion into these little known habitats, particularly during extended jungle operations, would entail exposure to forest-dwelling sand flies. Although not immediately incapacitating, leishmaniasis would be detrimental for units and individual soldiers 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 amastigotes multiply, eventually rupturing the macrophages, and dispersing to infect other macrophages. Hosts may remain infective for feeding sand flies for a few months to several years. Wild canines and domestic dogs are proven and significant reservoirs of *L. chagasi*. Reservoirs of other parasite species may include sylvatic rodents, sloths, canines, and humans. Reservoirs in some localities remain unknown. As the list of potential sand fly vectors continues to grow, new species of *Leishmania* are being discovered. At least 14 species of *Leishmania* have been identified in the Americas. *Leishmania* (*Viannia*) *brasiliensis*, *L.* (*V.*) *guyanensis*, *L.* (*V.*) *panamensis*, and *L.* (*L.*) *mexicana* have been documented in Ecuador.

3. Vector Ecology Profile. Some man-biting sand fly species do not transmit *Leishmania* parasites. Important proven vectors in Ecuador identified by the WHO Expert Committee on Control of Leishmaniasis (1990) includes *Lutzomyia* (*Nyssomyia*) *flaviscutellata*, *Lu.* (*N.*) *trapidoi*, *Lu.* (*Lutzomyia*) *gomezi* and *Lu.* (*Helcocyrtomyia*) *hartmanni*. In addition, Killick-Kendrick (1990) lists *Lu.* (*Psychodopygus*) *c. carrerai* as a proven vector 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* are annotated in a listing of Ecuadorian *Lutzomyia* species, Appendix B.5.

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, and animal shelters. Collecting from human bait has the advantage of capturing anthropophilic species, but is a risky practice in endemic areas. 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. Onchocerciasis. The causative agent of onchocerciasis is a filarial worm, *Onchocerca volvulus*, transmitted by black flies. Onchocerciasis (river blindness) in Ecuador is characterized by fibrous nodular skin lesions, which occur primarily on the scapular areas of the trunk and on the iliac crest. After many years, untreated victims may experience impaired vision or blindness.

1. Military Impact and Historical Perspective. The first case of onchocerciasis in Ecuador was reported in 1952 on the western slopes of the western cordillera of the Andes. Subsequently, additional foci were identified in Esmeraldas Province along the upper reaches of the Cayapas, Canand¾Cojimies, Onzole, Sucio, Viche, Sapallo Grande and Santiago rivers and their tributaries. During 1990-1995, residents of 33 communities along these hyperendemic river systems received an antihelminthic drug twice a year, with dramatic decreases in the prevalence of the disease. Although the risk of transmission is low, the greatest period of exposure is during the wet season (December through April), when adults of *Simulium exiguum* are most prevalent. Although the focus of onchocerciasis is limited to Esmeraldas Province, the vector is found abundantly east of the Andes in the San Miguel, Coca and Aguarico river systems of Napo Province. Numerous potentially infected individuals (reservoirs) have migrated from Esmeraldas to Napo Province. Infection with filarial worms would have no impact on military operations but might require substantial subsequent medical treatment for individual soldiers.

2. Transmission Cycle. Humans are the primary host/reservoir for the filarial worm, *Onchocera volvulus*. Black flies (*Simulium* spp.) feeding on humans ingest the microfilariae found in the skin. The microfilariae penetrate the thoracic muscles, develop into infective larvae (up to 14 days), migrate to the head capsule, and escape into the wound via the mouthparts during feeding. The larvae develop within nodular skin lesions but females do not produce microfilariae until they reach maturity (6-12 months). The female filarial worms remain in the nodules and produce microfilariae, which migrate to various regions of the body, occasionally locating in the eye and causing visual impairment or blindness. Heavy infections can build up only from exposure to repeated bites by infected *Simulium* over a prolonged period. Untreated victims can serve as reservoirs of microfilariae for as long as 15 years (life span of a female worm).

3. Vector Ecology Profile. The primary vector of *O. volvulus* in Ecuador is *Simulium exiguum*. The vector capacity of *S. quadrivittatum* is comparable to *S. exiguum*, however, since populations of *S. quadrivittatum* are reportedly small, it is considered less important. *Simulium exiguum* is thought to have three sibling species in Ecuador. Other man biting Simulidae in the endemic localities of Ecuador include *S. antillarum*, *S. metallicum*, *S. gonzalezi*, *S. mexicanum* and *S. lewisi*. Disease vector ecology profiles for *S. exiguum* and *S. quadrivittatum* are presented in Appendix A.7. *Simulium metallicum* is known to comprise at least 11 cytospecies. A list of black flies known to occur in Ecuador and important keys for their identification are presented in Appendices B.6 and G, respectively.

4. Vector Surveillance and Suppression. Small streams (less than 20 m across) do not generally support larval/pupal development of *S. exiguum*; therefore, surveillance efforts should be conducted on larger, rapid-flowing streams. This multivoltine species has at least two developmental cycles per year. Surveillance of aquatic habitats will provide information to determine timely control strategies coinciding with the larval stage and target species. Visual inspection of streams/rivers and sampling of larvae from all areas of a body of water (e.g., rocks, submerged vegetation and debris, etc.) will provide information on species composition, stage of development, and population dynamics. The most favorable time to control black fly populations is during the aquatic larval stages (before pupation). Caution is required when assessing larval populations of *S. exiguum*, since they are distinguishable from *Simulium gonzalezi* (an unimportant sympatric species) only during the pupal and adult stages. Formulations of *Bacillus thuringiensis israelensis* are economical, operationally feasible, and effective in controlling black fly populations. Chemical control measures are largely ineffective for controlling adult populations. Personnel should avoid open sunlit areas along streams, wear permethrin-treated BDUs with sleeves down during the daytime, and apply extended-duration deet repellent on exposed skin surfaces. Avoid wearing shorts during all daytime activities because *S. exiguum* and *S. quadrivittatum* bite primarily below the waist.

C. 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 of transmitting 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 rather painless 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 the febrile illness. Symptoms usually occur 16-22 days following the bite of an infected sand fly, although they may not materialize for 3-4 months. Man is the only known reservoir of *B. bacilliformis*, which may circulate in the blood for weeks prior to clinical symptoms and for years thereafter. The bacteria may be transmitted during blood transfusions. Untreated, fatalities are estimated at 10-20%; however, the bacterium is susceptible to antibiotic therapy.

1. Military Impact and Historical Perspective. Bartonellosis is known only from Colombia, Peru and Ecuador. It is most wide spread in Ecuador, occurring in lower coastal areas <800 m as well as higher elevations of the Andes. In contrast, bartonellosis usually occurs only at higher elevations (600-2,450 m) in Colombia and Peru. Outbreaks of bartonellosis were reported in the Ecuadorian provinces of Guayas, Los Rios, and El Oro in 1939. In 1940, an epidemic occurred in Zumba (Zamora-Chinchipe Province) and simultaneously in Zaruma (El Oro Province). Following the 1940 outbreaks, sporadic cases occurred in the Andean Plateau provinces of Azuay and Tungurahua. Most cases in recent years (from 1968 to date) have been reported from the uplands of Pajan and the Chongon-Colonche ranges (low hills <650 m) in Manabi and Guayas Provinces. These areas can be characterized as arid scrub forests with Kapok trees. Cases occur primarily toward the end of the rainy season. American troops with no immunity to this disease might well experience a repeat of the Peruvian epidemic 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 crossed the Rio Rimac at the Verrugas Bridge. A cavalry unit, traveling to the area with a consignment of silver, reportedly all died. Although readily treatable today, many cases of bartonellosis at known endemic sites could occur rapidly among nonimmune personnel, resulting in considerable down time. Outside the known endemic areas, cases would be minimal, 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 single leaf-eared mouse (*Phyllotis* sp.) from neighboring Peru in 1948. Domestic guinea pigs (*Cavia porcellus*) and chickens have been implicated as reservoirs in Ecuador. *Lutzomyia* sand flies are suspected vectors, but transmission patterns are unknown.

3. Vector Ecology Profile. Although never proven, man-biting sand flies are suspected as the vectors of *Bartonella* organisms. Dominant anthropophilic species in low elevation endemic foci of the Pajan region are *Lu. gomezi*, *Lu. panamensis* and *Lu. shannoni*, with smaller numbers of *Lu. sallesi* and *Lu. serrana*. At higher elevations, man-biting species of *Lu. serrana* and *Lu. nevesi* occur in the endemic area of Zumba (Zamora-Chinchipe Province, >800 m) and *Lu. ayacuchensis* occurs in the endemic region of Azuay Province (2,300-2,500 m). Peak populations of *Lu. ayacuchensis* occur from February to July.

4. Vector Surveillance and Suppression. See leishmaniasis, paragraph V.A.4., for surveillance and suppression of sand flies. Since little is known regarding 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.

VI. Other Diseases of Potential Military Significance

A. Leptospirosis. Leptospirosis is caused by a number of different bacteria belonging to the genus *Leptospira*. Over 200 serovars have been categorized as pathogenic. Individual serovars are often associated with a particular host; however, humans are considered only incidental and dead-end hosts. Military troops are often exposed to *Leptospira interrogans*, serovar *icterohaemorrhagiae*, which occurs in wild rodent populations. Rodents pass the leptospires in their urine. Ingestion of contaminated food or water or contact with abraded skin and mucous membranes are the usual modes of transmission. Symptoms appear 4-19 days following infection and include sudden onset of fever, headache, chills, and severe myalgia of the calves and thighs. More complicated symptoms may follow. Erroneous diagnoses often include encephalitis, meningitis, or influenza. Rodent excreta are commonly flushed from their runs, burrows, etc. into the water systems; therefore, leptospirosis frequently follows natural drainages. Flooding enhances the likelihood of transmission from animals to man in at least two ways: 1) it brings the maintenance host for the organism in closer contact with humans; and 2) it disseminates the infectious urine of host animals, resulting in exposure of many more persons. As the rainy season ends and streams begin to dry up, the leptospires become concentrated and are an increased threat to those who may bathe in or drink the water. Avoid wading, bathing, or drinking untreated water and ensure that sanitation is maintained to eliminate sources of food and harborage attractive to rodents.

B. Rabies. Rabies is a zoonotic viral disease transmitted through the saliva of animal bites. 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 in the Cordillera del Condor (villages of Kunkuki, Numbatkaime, and Warinta), Zamora-Chinchipe Province. Vampire bats (*Desmodus rotundus*) feeding on cattle decimated herds in the area, and 75% of the human population reported being bitten by vampire bats during their sleep. Troops occupying the southeastern lowlands of the Rio Cenepa drainage should be educated about the dangers posed by vampire bats. Soldiers should avoid contact with local dogs, cats, and other animals. Sleeping under bednets, when possible, will offer protection. 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 have the capacity to 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 topography and climate of Ecuador are somewhat comparable. Mosquitoes are major pests of tropical and semi-tropical regions but are discussed above. Consult Appendix B.1. for mosquitoes that occur in Ecuador. 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. The dual use of repellents on the skin (deet) and on the clothing (permethrin) (DoD Insect Repellent System) combined with proper wearing of the BDU will provide the individual soldier with nearly complete protection from most arthropods (TIM 36). Africanized honey bees, 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. *Culicoides furens* is a significant source of irritation in Pacific coastal areas associated with mangrove swamps.

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 adult female 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 may also 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 caterpillars in the tropics have poisonous urticating hairs 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, irritating 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 east of the Andes below 2,800 m (9,184 ft). Dermatitis is caused by poisonous abdominal setae of the female moths. Except indirectly, humans seldom contact 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 float and are carried by air currents, and ultimately are inhaled or land on the skin of unsuspecting people. The moths emerge twice a year. Every 4-5 years an emergence cycle 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 antihistamines 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. 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 fly, although rivers and streams flowing out of the Andean foothills (toward the coast and toward the eastern lowlands) do produce black fly species that are annoying to humans. All anthropophilic black fly species in South America belong to the genus *Simulium*. *Simulium* *quadrivittatum*, *S. exiguum*, *S. metallicum*, and *S. oyapokense* display some degree of anthropophily in Ecuador. *Simulium* species reported in Ecuador 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 Ecuador are *Pulex simulans*, *P. irritans* (human flea), *Ctenocephalides canis* (dog flea), *Ctenocephalides felis felis* (cat flea), *Xenopsylla cheopis* (Oriental Rat flea) and *Tunga penetrans* (sand flea, chigoe, jigger). *Pulex simulans* and *P. irritans* are frequently confused. *Xenopsylla cheopis*, the premier vector of plague, normally does not leave its common 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 biting humans. *Xenopsylla cheopis* is most common where humidity is high (usually <2,800 m). 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 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. *Tunga penetrans*' ability to penetrate skin and remain embedded can cause extreme discomfort. Blousing trousers inside boots is essential in providing a barrier. Fleas will crawl under blousing garters.

7. Tabanidae (deer/horse flies). Species belonging to the genera *Chrysops*, *Haematopota* and *Lepiselaga* are important biting 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. Exposure is greatest close to sources of water and in low-lying areas. They 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 dissolved tissue fluids. 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 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 that are subject to secondary infections. Their bites can become a serious morale problem for individuals, particularly those that are sensitized. The host-seeking behavior of chiggers and ticks are 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. Initial 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. 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 Ecuador 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. *Centruroides margaritatus* occurs in northwestern lowland areas and in neighboring Colombia. It reportedly inflicts more stings than any other scorpion, although it is not an extremely poisonous species. Scorpions are most active at night and may crawl into clothing and bedding. See precautions in paragraph VII.A., 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 Ecuador. 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* and *P. fera*, but the Brazilian species *Phoneutria nigriventer* has a reputation for being extremely aggressive and inflicts many serious bites. *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 the 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 Ecuador. 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* ssp. and *Micrurus* spp.) occur in the Neotropical region. Although extremely toxic, coral snakes' timid, 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, the deliver copious amounts of venom, and they frequently bite 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) may be concentrated along the high water line, increasing the risk of bites. Venoms of viperids vary in toxicity from species to species. Most deaths 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* ssp., rarely encountered because of its preference for nocturnal activity) and the tropical rattlesnake (*Crotalus durissus* ssp.), reputedly the most dangerous snake in the Americas. Venomous snakes known to occur in Ecuador 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). Poison ivy and poison oak in North America belong to the genus *Toxicodendron*. These are abundant at many CONUS installations, often causing skin reactions that require soldiers to be placed “on quarters” or occasionally in the hospital. The seriousness of lesions caused by poison ivy or poison oak is exacerbated in the tropics. The cashew nut is extremely toxic if eaten uncooked, and the resin in the plant and fruit can inflict extensive skin damage. Troops should be taught to recognize poisonous plants.

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

VECTOR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Anopheles darlingi	Principal vector east of the Andes in jungle and savanna lowlands of Amazon Basin.	Most prevalent during rainy season (January-March). Populations decrease during the dry season.	Generally a riverine species, but also reported in clear water in streams, ponds, and swamps with algae and floating vegetation. Seems to be more prevalent in larger bodies of water. Full sun or partial shade. Areas of secondary growth. Water temperatures may vary from 17-33 C. Requires pH near 7.0.	Exophagic[1] or endophagic[2]. Biting activity peaks 30 minutes after sunset with a smaller peak just before sunrise.	Endophilic[3]. Rests on walls 10 minutes before biting. After feeding, rests on vertical surfaces within 2 m of floor, or on ceilings.	Routinely 200-1,500 m. Maximum: 1.6 km.
Anopheles pseudopunctipennis	Primary vector in Los Chillos Valley along Guallabamba River drainage between 1,800-2,600 m.	Onset of dry season (June-September).	Sunny pools left along rivers in the dry season. *Spirogira* required for larval development. Water temperatures between 18-20 °C, pH 7.5-8.5.	More anthropophilic than zoophilic. Exophagic or endophagic. Peak biting activity is dusk and dawn.	Prefers upper rafter areas indoors. Negatively phototrophic.	Females: 3-6 km. Males: 400-500 m.
Anopheles albimanus	Humid lowland areas below 400 m in Guayas, El Oro, and Los Rios Provinces.	Unknown.	Areas of secondary growth in full sunlight/partial shade. Clear to polluted water with scum/algae, springs, seepages, borrow pits, streams, canals, and ponds. Associated vegetation: species of *Pistia*, *Elodea*, *Naias*, *Chara*, and *Utricularia*.	Anthropophilic or zoophilic. Mostly exophagic. Most actively bites from dark to midnight.	More exophilic[4] than endophilic. Will rest in any protected wooded area.	Routinely 400-600 m. Maximum: 3 km.
Anopheles calderoni	Coastal lowlands below 250 m.	Unknown.	Small streams, irrigation canals, swamps associated with dense emergent vegetation, especially cattails (*Typhas* spp.). Prefers water temperatures of around 26 °C.	Anthropophilic.	Unknown.	Unknown.
Anopheles aquasalis	Pacific coastal lowlands from provinces of Esmeraldas in north to El Oro in south.	Unknown, but in Rio de Janeiro, Brazil this species occurs throughout year with highest populations during low/moderate rainfall.	Prefers brackish water, 0.2-1.5% NaCl, but will breed in fresh water. Water free of plants in shade.	More zoophilic, but humans become primary host when domestic animals are removed. Biting peaks for several hours after sunset. May remain active throughout night.	Endophilic. Usually rests on walls less than 1 m from floor.	Unknown in Ecuador, but 350-2,000 m in Panama.
Anopheles trinkae	Primary vector along foothills of eastern slopes of Andes transitioning to lowlands of the Amazon Basin.	Dominant during 8-9 months of the rainy season (September –April/May).	Transitional temporary pools.	Unknown.	Unknown.	Unknown.

[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 Ecuador.

VECTOR	VIRUS	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Aedes aegypti (*Aedes albopictus*)[1]	Dengue, Urban Yellow Fever	In urban, suburban, and rural communities in the provinces of Esmeraldas, Manabi, Los Rios and Guayas.	Populations increase at the onset of the rainy season when artificial containers are filled and vectors are prone to congregate indoors.	Almost exclusively in artificial containers associated with man, i.e., discarded tires, flower pots, vases, rain gutters, rain barrels, cisterns, etc. Occasionally breeds in leaf axils such as *Agave* spp. and banana palms. Females lay single eggs, 3 larval stadia develop in 9 days (4-7 with ideal temperatures), pupae 1-5 days.	Aggressively anthropophilic. Equally exophagic and endophagic. Biting occurs throughout the day light 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 forests along eastern Andes and lowland rain forests in Napo and Pastaza Provinces.	Present year round, but population peak during the wettest season (January to May) and decline during dryer spells (June-September).	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 and 1600 hours, with no eggs laid at night. Most eggs are laid during rainy periods.	Little biting activity outside of 1200-1400. Will leave canopy to bite at ground level, especially in damaged forest and along forest edges. Bites during the daytime only, primarily between 1200-1400 hours in forests.	Canopy mosquito.	Unknown but thought to be very limited.
Sabethes chloropterus	Sylvatic Yellow Fever	Mountain forests along eastern Andes and lowland rain forests in Napo and Pastaza Provinces.	Adult in forest throughout year and most prevalent during rainy season (July-September in Panama). Adults found through dry season when species of *Haemagogus* are absent.	Tree hole breeders with preference for large cavities with small openings that hold water through dry season. Can survey for eggs with bamboo traps (tops closed with small hole through the side). Population drops in dry season.	Aggressive human biters. 10% of the specimens in a Panama study were collected at ground level using human bait.	Canopy mosquito.	Unknown.

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

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. Disease Vector Ecology Profile: Reduviid Vectors of Chagas Disease in Ecuador.

VECTOR	GEOGRAPHIC DISTRIBUTION	BIONOMICS/HABITAT INFORMATION	BITING BEHAVIOR
Triatoma infestans	Widely distributed and up to 4,100 m in the inter-Andean valleys of Ecuador.	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 even larger livestock shelters. Tolerates temperatures between 10°C-37°C. Prefers warm climate with low humidity. Populations peak during rainy season. Life cycle may extend over 2 years, 5 nymphal stages and adults live as much 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 *Galea* spp., didelphids, *Microcavia,* and *Graomys.* Aggressive feeder. Thermotrophic and attracted to CO_2. Painless bite with little reaction. Feeds every few weeks.
Rhodnius prolixus	Northern Ecuador	Well established in human habitations. Peridomestic in chicken houses and pigeon coops. Associated with birds (*Jabira mycteria* and *Mycteria americana*). Birds may transport eggs in their feathers to new locations. Collected on species of palms. Palm fronds used by local people to construct houses may start the domestic cycle or re-infest following eradication. Localizes in palm-thatched roofs, wall cracks, and household effects. Two cycles produced per year.	Strongly anthropophilic, weakly zoophilic. Aggressive feeder. Painless bite without reaction. Defecates within 10 minutes of feeding.
Triatoma dimidiata	Exclusively along Pacific Coast	Domestic and peridomestic in urban and rural structures. Prefers densely forested areas. May be infected with *Triatoma cruzii* for life. Maintenance of sylvatic cycle of *T. cruzi* more important than domestic contact with man. Frequently covered with soil particles. Common in burrows of armadillo. Attracted to lights.	Strongly zoophilic, weakly anthropophilic. Rodents and chickens are the main blood source. Non-aggressive feeder. Feeds 10-20 minutes. Flagellates in feces 12-15 days post infected meal. Produces pruritis and erythema.
Rhodnius ecuadoriensis	Andean valleys of southern Ecuador	Domestic, peridomestic and sylvatic, collected in guinea pig pens, hollow trees, etc. Domiciliary habits of recent origin. If chickens are in houses, this species will be there. Optimal temperatures 28°–30°C. Readily reproduces in domiciliary situation.	Dogs, rats, chickens, *Cavia*. Secondarily anthropophilic.
Panstrongylus chinai	Pacific slopes of Andes from sea level to 1,500 m. Amazon drainage basin.	Naturally infected with *T. cruzi*. A weak potential vector. Has been found in homes, but not truly domestic. Attracted to lights. Evidence of colonization is presence of nymphs.	Secondarily anthropophilic.
Triatoma carrioni	Between 1,000 and 2,650 m.	Semi-domestic species, attacking humans, horses, and collected in forest animal burrows.	Secondarily anthropophilic.

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

VECTOR	GEOGRAPHIC DISTRIBUTION	POTENTIAL HOSTS	BIONOMICS/HABITAT INFORMATION	ASPECTS OF TRANSMISSION
Xenopsylla cheopis	Primary vector at elevations below 2,800 m throughout country, although it will occur at higher elevations.	*Rattus rattus, Rattus norvegicus, Cavia porcellus*	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 in 12-21 days after ingesting plague bacilli. Found to feed readily on 75 different hosts, including man. Can jump 20 cm vertically. Burrowing *Rattus* spp. usually harbor more *X. cheopis* than those confined to surface habitats.
Pulex irritans (*P. simulans*)[1]	Implicated as primary urban vectors at elevations above 2,800 m, particularly in Chimborazo and Loja Provinces.	*Rattus rattus, Rattus norvegicus, Cavia porcellus, Canis familiaris, Sus scrofa*	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, accessing hosts by jumping on, 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	Thought to replace *X. cheopis* above 2,800 m.	*Rattus* spp.	Little known of life cycle. Probable nest dwelling flea.	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*	All stages are found in bedding substrata of guinea pigs and adults are found on the guinea pigs.	Transport of *C. porcellus* from one area to another as a food commodity is 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 southeastern region and areas surrounding the eastern side of the Bay of Guayaquil.	*Sciurus stramineus Oryzomys* spp.	Fleas found on *Sciurus stramineus* and in their nests. Little else known.	Important only in maintenance of enzootic plague.

[1] *Pulex irritans* and *Pulex simulans* have similar ecological profiles and the two species are frequently confused.

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

VECTOR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	BIOLOGY/HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Lutzomyia flaviscutellata	Highland valleys of northern Ecuador and eastern lowlands.	Populations present throughout year, but significant population begins towards end of dry season and declines as rainy season commences.	Found in dry secondary forests. Species has been colonized in laboratory. Egg to adult averages 40.5 days. Males emerge before females. Females and males live 17-41 days (ave. 27) and 2-12 days (ave. 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, armadillos and marsupials, but will bite humans entering their habitat. Females will feed as many as four times during life span. Successful biting collections have been taken during the first four hours after dark.	Unknown.	Unknown.
Lutzomyia trapidoi	Lowland coastal areas in the providences of Esmeraldas, Guayas, Manabi, and Los Rios.	Major peaks occur in July and in December/ January, but prevalent throughout year (Panama).	Colonized species. Readily attracted to light traps. One report indicates the species inhabits mature forests, and a second study reports that it inhabits only disturbed forest and undergrowth of coffee plantations, especially near dwellings. Reluctant to enter clearings. Two sibling species known to occur. 21 eggs/cycle. Egg to adult 33-47 days. Undergoes up to 4 gonotrophic cycles (autogeny not reported).	Canopy biter, but bites in under story during daytime. Exophagic and exophilic. Migrates upward at night. Peak activity 1900-2030 hours, but bites throughout night. A 2nd report indicates peak biting within 3 hours either side of midnight.	Females rest on tree trunks between 0.6-2 m and males rest in leaf litter (Panama study).	Routinely <57 m. Maximum: 200 m.

Appendix A.7. Disease Vector Ecology Profile: Black Fly Vectors of Onchocerciasis in Ecuador.

VECTOR	GEOGRAPHIC DISTRIBUTION	TRANSMISSION SEASON	LARVAL HABITAT	BITING BEHAVIOR	RESTING BEHAVIOR	FLIGHT RANGE
Simulium exiguum	River drainage on western slopes of western cordillera in the Rio Santiago drainage, Esmeraldas Province.	During two dry seasons, Dec through Feb and Jun through Aug, especially the latter. Parasite development is more rapid during the dry season, thus greater transmission.	Low altitudes (100 m) in middle reaches of fast flowing large (5 meters or greater) sunlit rivers or up to 2,000 m in small slow flowing streams. Stones, wood debris, and submerged vegetation in deep parts of river. Water running over shingle rock beds.	Anthropophilic in absence of equines or bovines. 80% of bites are below the waist. Actively feed in open sunlight, less in shade. Bites throughout day with bimodal peaks first hour after daylight and in afternoon in low wind conditions	On vegetation along banks of breeding areas and at forest edges.	Maximum 3-4 km.
Simulium quadrivittatum	River drainage on western slopes of western cordillera in the Rio Santiago drainage, Esmeraldas Province.	Populations peak in wet season, but parasite development is slower at this time.	Small shaded forest streams on submerged plants and debris.	Anthropophilic and will feed on equines. Bites throughout day, with mid-morning and afternoon peaks. Bites mainly on lower extremities.	Unknown.	Unknown.

Appendix B: Arthropod Species

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

Aedeomyia (*Aedeomyia*)
- *squamipennis*

Aedes (*Howardina*)
- *brevivittatus*
- *ecuadoriensis*
- *sexlineatus*

Aedes (*Ochlerotatus*)
- *angustivittatus*
- *crinifer*
- *fluviatilis*
- *fulvus*
- *hortator*
- *milleri*
- *scapularis*
- *serratus*
- *taeniorhynchus*

Aedes (*Protomacleaya*)
- *metoecopus*

Aedes (*Stegomyia*)
- *aegypti*

Anopheles (*Anopheles*)
- *apicimacula*
- *calderoni*
- *eiseni*
- *mediopunctatus*
- *pseudopunctipennis*
- *punctimacula*

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

Anopheles (*Lophopodomyia*)
- *gomezdelatorrei*

Anopheles (*Nyssorhynchus*)
- *albimanus*
- *aquasalis*
- *oswaldoi*
- *rangeli*
- *triannulatus*
- *trinkae*

Chagasia bathana

Coquillettidia (*Rhynchotaenia*)
- *arrihalzagae*
- *fasciolata*
- *lynchi*
- *venezuelensis*

Cules (*Aedinus*)
- *amazonensis*

Culex (*Carrollia*)
- *babahoyensis*
- *bihaicola*
- *bonnei*
- *infoliatus*
- *secundus*
- *urichii*

Culex (*Culex*)
- *archegus*
- *articularis*
- *camposi*
- *chidesteri*
- *coronator*
- *declarator*
- *dolosus*
- *guayasi*
- *levicastilloi*
- *mollis*
- *nigripalpus*
- *quinquefasciatus*
- *quitensis*
- *usquatissimus*

usquatus

Culex (*Melanoconion*)
adamesi
bastgarius
batesi
comminutor
conspirator
distinguendes
dunni
eastor
educator
elevator
erraticus
evansae
lucifugus
ocossa
oedipus
pedroi
penai
pilosus
psatharus
putumayensis
saramacensis
spissipes
sursumptor
taeniopus
vomerifer

Culex (*Phenacomyia*)
corniger

Deinocerites pseudes

Haemagogus (*Haemagogus*)
acutisentis
boshelli
janthinomys
lucifer
panarchys
soperi
spegazzinii

Johnbelkinia longipes
ulopus

Limatus andinus
durhamii
guayasi

Mansonia (*Mansonia*)
indubitans
titillans

Phoniomyia esmeraldasi

Psorophora (*Grabhamia*)
cingulata
confinnis

Psorophora (*Janthinosoma*)
albgenu
ferox
lutzii

Psorophora (*Psorophora*)
cilipes
lineata

Sabethes (*Sabethes*)
bipartipes

Sabethes (*Sabethoides*)
chloropterus

Toxorhynchites (*Lynchiella*)
haemorrhoidalis
theobaldi

Trichoprosopon andinum
digitatum
lanei
mogilasium
vonplesseni

Uranotaenia (*Uranotaenia*)
aequatorianna
geometrica
leucoptera
lowii
pulcherrima
typhlosomata

Wyeomyia (*Wyeomyia*)
arthrostigma
chalcocephala
melanocephala

Wyeomyia (*Dodecamyia*)
aphobema

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

Appendix B.2: Species of Kissing Bugs Reported from Ecuador*

Cavernicola pilosa [2]

Eratyrus cuspidatas [2]

Panstrongylus chinai [1]
Panstrongylus geniculatus [3]
Panstrongylus howardi
Panstrongylus rufotuberculatus

Rhodnius ecuadoriensis [1] (southern Ecuador)
Rhodnius pictipes [3]
Rhodnius prolixus [1]
Rhodnius robustus [3]

Triatoma carrioni [1] (southern Ecuador)
Triatoma dimidiata [1]
Triatoma dispar
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 humans.
[3] Found naturally infected with *T. cruzi* in Napo and Sucumbios Provinces.

***Reference: Brenner and Stoka 1987**

Appendix B.3 Species of Fleas and Their Hosts Reported from Ecuador*

Flea Species	**Hosts**
Ceratophyllidae	
Kohlsia campaniger	*Hesperomys*
Nosopsyllus londiniensis	*Cavia* (guinea pigs), *Mus* (house/rice field mice), *Phyllotis* (leaf-eared mice), *Rattus* (rats)
Plusaetis dolens quitanus	*Oryzomys* (rice rats), *Thomasomys* (Thomas's paramo mice)
Plusaetis equatoris	*Akodon* (grass mice), *Oryzomys* (rice rats), *Rhipidomys* (climbing mice)
Plusaetis smiti	*Oryzomys* (rice rats), *Thomasomys* (Thomas's paramo mice)
Ctenophthalmidae	
Adoratopsylla intermedia intermedia	*Didelphis* (opossums)
Adoratopsylla intermedia copha [2]	*Didelphis* (opossums)
Neotyphloceras crassispina crassispina	*Phyllotis* (leaf-eared mice)
Neotyphloceras rosenbergi [2]	*Sigmodon* (cotton rats), *Thomasomys* (Thomas's paramo mice), marsupials
Leptopsyllidae	
Leptopsylla segnis [1]	*Akodon* (grass mice), *Cavia* (guinea pigs), *Mus* (house/rice field mice), *Rattus* (rats)
Pulicidae	
Cediopsylla spillmanni [1]	*Sylvilagus ecaudatus* (cottontail rabbit)
Ctenocephalides canis [1]	*Canis* (dogs), *Felis* (cats)
Ctenocephalides felis felis [1]	*Canis* (dogs), *Felis* (cats), *Rattus* (rats)
Echidnophaga gallinacea	multiple domestic animals
Euhoplopsyllus andensis	*Sylvilagus* (cottontail rabbits)
Hectopsylla eskeyi [1,2,3]	*Cavia* (guinea pigs)
Hectopsylla suarezi [1,2]	*Cavia* (guinea pigs), *Rattus* (rats), *Oryzomys* (rice rats), *Sigmodon* (cotton rats)
Pulex irritans [1]	*Canis* (dogs), *Cavia* (guinea pigs), *Conepatus* (hog-nosed skunks), *Felis* (cats), humans, *Lagostomus* (plains viscaacha)
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	*Cavia* (guinea pigs)
Rhopalopsyllidae	
Polygenis bohlsi bohlsi	*Akodon* (grass mice), *Nectomys* (neotropical water rats)
Polygenis brachinus	*Akodon* (grass mice), *Oryzomys* (rice rats)
Polygenis litargus [2,3]	*Akodon* (grass mice), *Oryzomy* (rice rats), *Rattus*, *Rhipidomys*, *Sciurus* (tree squirrels)
Polygenis roberti beebei	*Oligoryzomys* (rice rats)
Polygenis roberti roberti	*Oligoryzomys* (rice rats)
Rhopalopsyllus cacicus	*Didelphis* (opossums)
Tetrapsyllus comis	*Akodon* (grass mice), *Sigmodon* (cotton rats), *Thomasomys* (Thomas's paramo mice)
Tiamastus cavicola [2,3]	*Cavia* (guinea pigs), *Oryzomys* (rice rats), *Rattus* (rats)
Stephanocircidae	
Cleopsylla monticola	*Caenolestes* (common shrew opossums)
Craneopsylla minerva minerva	*Phyllotis* (leaf-eared mice)
Plocopsylla achilles	*Oryzomys* (rice rats), *Thomasomys* (Thomas's paramo mice)
Plocopsylla hector [2]	*Thomasomys* (Thomas's paramo mice)
Plocopsylla heros	*Blarina* (short-tailed shrews)
Plocopsylla phobos	*Thomasomys* (Thomas's paramo mice)
Plocopsylla phyllisae	*Oryzomys* (rice rats)
Plocopsylla ulysses	*Thomasomys* (Thomas's paramo mice)
Sphinctopsylla inca	*Oryzomys*, *Thomasomys* (Thomas's paramo mice)
Sphinctopsylla tolmera	*Oryzomys* (rice rats), *Thomasomys* (Thomas's paramo mice)
Sphinctopsylla spillmanni	*Caenolestes* (common shrew opossums)

[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.4: Species of Ticks and Their Hosts Reported from Ecuador*

Tick Species	Hosts
Argasidae	
Argas magnus	
Argas reflexus	
Ornithodoros capensis	*Diomedea irrorata*
Ornithodoros darwini	
Ornithodoros denmarki	*Diomedea irrorata*
Ornithodoros furcosus	cattle, horse
Ornithodoros galapagensis	
Ornithodoros rudis	
Ornithodoros talaje	
Ornithodoros transversus	*Geochelone nigra*
Ixodidae	
Amblyomma boulengeri	*Tropidurus delanonis*
Amblyomma cajennense	human, burro, cattle, horse
Amblyomma calcaratum	*Taamandua tetradactyla* (anteater)
Amblyomma darwini	
Amblyomma dissimile	*Boa constrictor*
Amblyomma humerale	*Geochelone denticulata* (tortoise)
Amblyomma incisum	
Amblyomma macfarlandi	tortoise, *Geochelone nigra*
Amblyomma maculatum	burro, cattle
Amblyomma multipunctum	cattle, horse, *Tapirus roulinii* (tapir)
Amblyomma naponense	
Amblyomma nitidum	
Amblyomma ovale	human, dog,
Amblyomma pilosum	*Geochelone nigra*
Amblyomma sabanerae	*Rhinoclemmys annulata*
Amblyomma scalpturatum	tapir
Amblyomma testudinis	*Drymarchon corais*
Amblyomma triste	cattle, horse
Amblyomma usingeri	human, *Geochelone nigra*
Amblyomma williamsi	
Anocentor nitens	cattle, donkey, horse, *Equus asinus*
Boophilus microplus	cattle, horse, *Bos taurus* (ox)

Haemaphysalis juxtakochi	cattle, horse
Ixodes affinis	cat
Ixodes boliviensis	cattle
Ixodes cornuae	
Ixodes fossulatus	
Ixodes luciae	*Didelphis albiventris* (opossum)
Ixodes pomerantzi	*Sylvilagus brasiliensis* (cottontail rabbit)
Rhipicephalus sanguineus	dog

***Reference: Doss et al. 1978**

Appendix B.5: Species of Sand Flies Reported from Ecuador*

Lutzomyia (*Coromyia*)
vespertilionis

Lutzomyia (*Dampfomyia*)

Lutzomyia (Species Group *Saulensis*)
saulensis

Lutzomyia (*Evandromyia*)
infrasinosa

Lutzomyia (*Helcocyrtomyia*)
ayacuchensis[1, 3]
hartmanni [1, 6]
osornoi
strictivilla[1]
tortura[1]

Lutzomyia (*Lutzomyia*)
falcata
gomezi[1]
lichyi[1]
sherlocki
spathotrichia

Lutzomyia (Species Group *Verrucarum*)
nevesi[1]
serrana[1]

Lutzomyia (*Micropygomyia*)
micropyga
cayennensis cayennensis

Lutzomyia (Species Group *Oswaldoi*)
trinidadensis

Lutzomyia (*Nyssomyia*)
flaviscutellata[1, 3]
olmeca bicolor[1]
trapidoi[1,6]
yuilli yuilli[1]

Lutzomyia (*Pressatia*)
camposi
choti
dysponeta
triacantha

Lutzomyia (Species Group *Baityi*)
baityi
gorbitzi

Lutzomyia (*Psathyromyia*)
abonnenci
dasymera
dendrophyla[1]
shannoni[1]
undulata

Lutzomyia (Species Group *Aragaoi*)
abunaensis
aragaoi
barrettoi barrettoi
barrettoi majuscula

Lutzomyia (Species Group *Dreisbachi*)
aclydifera

Lutzomyia (*Psychodopygus*)
amazonensis
ayrozai[1]
bispinosa
carrerai carrerai[1, 3]
carrerai thula
davisi[1]
geniculata[1]
hirsuta hirsuta[1,3]
nocticola
panamensis[1, 4, 6]
paraensis

Lutzomyia (*Sciopemyia*)
sordellii

Lutzomyia (Species Group *Migonei*)
sallesi
sericea
walkeri

Lutzomyia (*Trichophoromyia*)
cellulana
naponensis
reburra
ubiquitalis[1,5]
wilkersoni
Lu. (*Trichophoromyia*) sp.

Lutzomyia (*Trichopygomyia*)
triramula

Lutzomyia (*Viannamyia*)
furcata
tuberculata[2]

Ungrouped *Lutzomyia* species
nocticola
Lu. sp. of *Anchicaya*

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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 panamensis*

***Reference: Young and Duncan 1994**

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

Simulium (*Ectemnapsis*)
- *ignescens*
- *jaimeramirezi*
- *pautense*

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

Simulium (*Notolepria*)
- *exiguum*
- *gonzalezi*

Simulium (*Psaroniocompsa*)
- *incrustatum*
- *jujuyense*
- *oyapockense*
- *quadrifidum*

Simulium (*Psilopelmia*)
- *bipunctatum*
- *dinellii*
- *escomeli*
- *lutzianum*
- *mayuchuspi*
- *quadrivittatum*
- *romanai*
- *shewellianum*

Simulium (*Pternaspatha*)
- *cotapaxi*

Simulium (*Simulium*)
- *metallicum*

Simulium (*Trichodagmia*)
- *chalcocoma*

***Reference: Kim and Merritt 1987**

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

Buthidae

Ananteris festae (Los Rios Province)

Centruroides gracilis (Likely in north coastal area, not confirmed)
Centruroides margaritatus (Guayas Province)

Tityus asthenes (Napo and Pinchincha Provinces)
Tityus bastosi (Napo Province)
Tityus demnagei (Morona-Santiago Province)
Tityus ecuadorensis (Luja Province)
Tityus forcipula (Cotopaxi and Pinchincha Provinces)
Tityus gasei (Napo Province)
Tityus jussarae (Napo Province)
Tityus pugilator (Imbabura, Carchii, and Pinchincha Provinces)
Tityus simonsi (Loja Province)

***Reference: Polis 1990**

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

Elapidae

Leptomicrurus narduccii (eastern Ecuador)
Leptomicrurus schmidti (considered *L. scutiventris* by some herpetologists)

Micrurus ancoralis (northwestern Ecuador)
Micrurus annellatus (southern Ecuador)
Micrurus bocourti (Pacific lowlands of western Ecuador)
Micrurus catamayensis (Catamayo Valley, Loja Province)
Micrurus dumerilii spp. (west of Andes)
Micrurus filiformis (eastern Ecuador)
Micrurus hemprichii (upper Amazon)
Micrurus langsdorffi (eastern Ecuador)
Micrurus lemniscatus [6] (Amazon region)
Micrurus margaritiferus (likely occurs east of Andes, but not confirmed)
Micrurus mertensi (southwestern Ecuador)
Micrurus mipartitus [6, 10]
Micrurus peruvianus (likely occurs, but not confirmed)
Micrurus petersi
Micrurus psyches (likely occurs east of Andes, but not confirmed)
Micrurus spixii [6] (Amazon region of eastern Ecuador)
Micrurus steindachneri (eastern slopes of Andes in Morona Santiago Province, and in Pastaza Province)
Micrurus surinamensis (Amazon region)
Micrurus tschudii (Pacific slopes of southern Ecuador)

Viperidae

Bothriechis schlegelii [6] (eye-lash pit viper, western Ecuador)

Bothriopsis albocarinata (eastern versant of Andes)
Bothriopsis alticola
Bothriopsis bilineata (emerald pit viper)
Bothriopsis punctata (western Ecuador)
Bothriopsis taeniata (east of Andes)

Bothrops asper [5, 6, 7, 10] (fer de lance, coastal areas)
Bothrops atrox [2, 6, 8, 9, 10, 11] (barba amarilla, equatorial forests)
Bothrops barnetti (likely occurs in southern coastal areas, but not confirmed)
Bothrops brazili (equatorial forests)
Bothrops lojanus (Loja and Zamora-Chinchipe Provinces)
Bothrops microphthalmus (Amazonian forests)
Bothrops monticelli (1,000-1,500 m)

Bothrops pulcher (eastern Amazonian lowlands)
Bothrops xanthogrammus (Pacific Andean slopes)

Crotalis durissus spp. (rattlesnake)

Lachesis muta [2, 4, 6, 9, 10, 11] (bushmaster, equatorial forests and Pacific slopes)

Porthidium hyoprora (forests of eastern Ecuador)
Porthidium nasutum (hog-nosed viper)

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 Antivenom*

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

Brazil – 2
FundaH>o 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
Facultad de Microbiologia
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 Ecuador 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
Caloptropis spp., found in dry open areas, milkweed (milky sap)
Comocladia spp.
Croton spp. (resinous oil)
Dalechampia spp., vines in disturbed areas, ortiguilla
Daphne spp. (sap - mezercin)
Euphorbia spp. (sap - euphorbin)
Hippomane mancinella (milky latex and fruit)
Hura spp. (sap)
Malpighia spp., found in dry deciduous forests
Mucuna pruriens
Ricinus spp., higuerilla, castor bean (dust of seeds)
Schinus spp., found in inter-Andean valleys
Sterculia spp.
Thevetia spp. (seeds, leaves, stems and roots)
Toxicodendron spp., alubillo, compadre, caspi, poison oak/ivy (seeds, leaves, bark)
Urera spp., urticating nettle, ortiga, ortiguilla de tigre, crespÙn

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

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

Ageratina altissima
Anacardium occidentale, cashew nut (nut and shell - anacardic acid)
Brugmansia spp., tree-like, campana (seeds)
Calophyllum inophyllum
Caloptropis spp., found in dry open areas, milkweed (milky sap)
Coriaria spp., sprawling shrub in open, woody lianas in forest (small fruits – corianmyratine)
Croton spp.
Daphne spp.
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, rabo de alacrán
Hippomane mancinella (milky latex and fruit)
Hura spp. (sap, seeds and bark)
Jacquinia spp.
Jatropha spp. (seeds)
Karwinskia spp.
Manihot esculenta, manihot, yuca (uncooked roots - hydrocyanic acid)
Melia spp.
Phytolacca spp., jaboncillo
Pilocarpus spp. (pilocarpine nitrate poisoning)
Pilea spp., found in cloud forests, some epiphytic
Ricinus spp., higuerilla, castor bean (seeds, leaves and stems)
Sapium spp.
Schinus spp., found in inter-Andean valleys
Solandra spp., found in cloud forests and wet lowland forests
Solanum spp., palo de ajo, chitchiva (fruits and leaves)
Strychnos spp., canopy lianas (contains curare alkaloids)
Thevetia peruviana, found in inter-Andean valleys, chilca (seeds, leaves, stems and roots)
Toxicodendron spp., alubillo, compadre, caspi, poison oak/ivy (seeds, leaves, stems)

***Additional information on vegetation is available on AFMICS'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 (Ed.), 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.

Kumm, H.W., E. Osorno-Mesa and J. Boshell-Manrique. 1946. Studies of Mosquitoes of the Genus *Haemagogus* in Colombia (Diptera, Culicidae). Am. J. Hyg., 43: 13-28.

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 indexes 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. Amer. Mus. Nat. Hist., 163(3): 125-520.

Simuliidae

CoscarÙn, S. 1987. El G¾nero *Simulium* Latreille en la RegiÙn Neotropical: An‹lisis de los Grupos Supraespec Íficos, Especies que los Integran y DistributiÙn Geogr‹fica (Simuliidae, Diptera). Museu Paraense Em Ílio Goeldi, Bel¾m, Brazil. 112 pp. (In Spanish).

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

CoscarÙn, 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.

Shelley, A.J., R.R. Pinger and M.A.P. Moraes. 1982. The Taxonomy, Biology and Medical Importance of *Simulium amazonicum* Goeldi (Diptera: Simulidae), with a Review of Related Species. Bull. Brit. Mus. (Nat. Hist.) Entomol., 44(1): 1-29.

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. Entomol. 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 Check List and Key. Bull., Mus. Comp. Zool., 122(9): 491-541.

Tabanidae

CoscarÙn, 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. 1979. Horse Flies of the Colombian Departments of Choco, Valle and Cauca. Cespedesia, 8: 87-433.

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): 554-6.

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 Ecuador

U.S. Embassy
Avenida 12 de Octubre and Avenida Patria
Quito, Ecuador
Country/City Code: 011-593-2
Telephone: 562-890/561-749

U.S. Embassy
Consulate General
9 de Octubre and Garcia Moreno
Guayaquil, Ecuador
Country/City Code: 011-593-4
Telephones: 323-570/321-152

Dr. Patricio Hevia
Representante de la OPS/OMS en el Ecuador
Oficina Sanitaria Panamericana
San Javier 295 y Francisco de Orellana
Quito, Ecuador
Country/City Code: 011-593-2
Telephones: 544-642/551-460/528-405/236-558
Fax: 502-830

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