

DISEASE VECTOR ECOLOGY PROFILE



HAITI

September 1994

Armed Forces Pest Management Board
**DEFENSE PEST MANAGEMENT INFORMATION
ANALYSIS CENTER**

Forest Glen Section, WRAMC
Washington, D.C.
20307-5001

MULTIPLE COPIES AVAILABLE ON REQUEST

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE SEP 1994		2. REPORT TYPE		3. DATES COVERED 00-00-1994 to 00-00-1994	
4. TITLE AND SUBTITLE Disease Vector Ecology Profile: Haiti				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Defense Pest Management Information Analysis Center, Armed Forces Pest Management Board, Forest Glen Section - Walter Reed Army Medical Center, Washington, DC, 20307-5001				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 21	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

PREFACE: Disease Vector Ecology Profiles (DVEPs) are concise summaries of vector-borne and other militarily significant diseases that occur in specific countries. DVEPs focus on vector-borne diseases and emphasize essential epidemiology, vector bionomics, behavior, and pesticide resistance. Selected bibliographies of pertinent disease and disease vector literature are included. DVEPs are compiled from unclassified literature and are intended to provide a historical profile of arthropod-borne disease epidemiology in the recent past for selected geographical areas.

The epidemiology of arthropod-borne disease is constantly changing, especially in developing countries undergoing rapid growth, ecological change, and/or large migrations of refugee populations. Therefore, DVEPs should be supplemented with recent information on foreign public health status and medical developments.

Current Information: Current disease risk assessments, additional information on other parasitic and infectious diseases, and other aspects of medical intelligence can be obtained from the Armed Forces Medical Intelligence Center (AFMIC), Fort Detrick, Frederick, MD 21701, (301) 619-7574, DSN 343-7511.

Additional information can be obtained from the Navy Preventive Medicine Information System (NAPMIS), which maintains up-to-date Disease Risk Assessment Profiles (DISRAPs) and Disease Vector Risk Assessment Profiles (VECTRAPS) on most countries of the world. DISRAPs and VECTRAPS can be obtained by contacting the Navy Environmental Health Center (NEHC), Norfolk, VA 23513, (804) 444-7575 extension 456, DSN 564-7575 ext 456.

Specimen identification support assistance and identification keys can be provided by the Walter Reed Biosystematics Unit, Museum Support Center, Silver Hill, MD (301) 238-3165.

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

For insect repellents, pesticides and respirators: contact the Defense General Supply Center ESOC at: DSN 695-4865 or commercial (805) 275-4865. This ESOC is staffed 7 days a week and 24 hours a day.

For application equipment: contact the Defense Construction Supply Center ESOC at: DSN 850-2271/3191 or commercial (614) 238-2271/3191.

For personal protection equipment (bed nets, head nets, etc.): contact the Defense Personnel Support Center at: DSN 444-3042/3043 or commercial (215) 737-3042/3043.

Contingency Operations Assistance: the AFPMB is staffed with a Contingency Liaison Officer (CLO) who can help identify the appropriate DoD personnel, equipment, and supplies necessary for vector

surveillance and control during contingencies. Contact the CLO at DSN 291-5191 or commercial (301) 427-5191, and by FAX at DSN 291-5045 or commercial (301) 427-5045.

DPMIAC Services: In addition to DVEPs, DPMIAC can provide bibliographic literature searches of the pest management, medical entomology, pest identification and pesticide toxicology database. DPMIAC can also conduct searches of other worldwide biomedical databases. DPMIAC publishes the Technical Information Bulletin (TIB), Technical Information Memoranda (TIMs), and the Military Pest Management Handbook. Telephone (301) 427-5365, DSN 291-5365, or by FAX at DSN 291-5466, commercial (301) 427-5466.

DPMIAC operates an electronic bulletin board system (BBS) that can be accessed through computer modem and an automated fax system. The systems have products of current operational interest and recent editions of the Technical Information Bulletin (TIB) available for downloading or automated faxing. The BBS phone number is (301) 427-5121; the Command Fax: 6770.

Acknowledgements: The Defense Pest Management Information Analysis Center would like to acknowledge the contractual support of Dr. David Bowles for the development of this document. Individuals who made significant contributions to this DVEP include: Navy Disease Vector Ecology Control Center (JAX), Dr. Gary Clark, CDC - San Juan Laboratories, Mr. Edward Saugstad, AFMIC (Technical Review), Dr. Richard Robbins and Capt Armando Rosales, AFPMB/DPMIAC (editorial review).

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

HAITI

TABLE OF CONTENTS

Map of Haiti	1
Introduction	2
Disease Risk Summary	4
 Militarily Important Diseases	 6
Malaria	6
Dengue	6
Bancroftian Filariasis	7
Mansonellosis	8
Louse-Borne Typhus	8
Diarrheal Diseases	8
 Other Vector-Borne Diseases of Potential Military Importance	 10
Eastern Equine Encephalitis	10
St. Louis Encephalitis	10
Leishmaniasis	11
Yaws	11
Dermal Myiasis	11
Subdermal Myiasis	12
Murine Typhus	12
Schistosomiasis	12
Leptospirosis	13
Rabies	13
 Appendices	 14
A. Mosquitoes of Haiti	14
B. <i>Culicoides</i> of Haiti	14
C. Other Flies of Potential Medical importance	15
D. Other Arthropods of Potential Medical Importance	15
E. Personal Protective Methods	15
F. Chemical Control of Pests and Vectors	16
G. Resistance to Pesticides	17
H. Snakes of Haiti	17
 Selected References	 18

The Map



INTRODUCTION

The Republic of Haiti, including the smaller islands of Gonave, Tortuga, Vache, Grand Cayemite, and Navassa, occupies the western one-third of the Caribbean island of Hispaniola. The remaining portion constitutes the Dominican Republic. Haiti is situated between 18° and 20° north latitude and between 71° and 74° west longitude, approximately midway between Cuba and Puerto Rico. Haiti has a land area of 27,749 sq km (10,714 sq mi) with a maximum length of about 180 miles (290 km). The width along the shared border with the Dominican Republic is 110 miles (177 km). The Gulf of Gonave bisects Haiti into narrow northwestern and southwestern peninsulas.

Haiti is a mountainous country with 40% of its land at elevations greater than 1500 ft (458 m). Less than 20% of the land lies below 600 ft (183 m). Haiti's five mountain ranges (Massif du Nord, Montagnes Noires, Chaîne de Mateaux, Massif de la Hotte, and Massif de la Selle) follow an east-west axis. The highest peak, Morne de la Selle, is 8,793 ft (2,680 m) in elevation. The remaining land area consists of four major flatlands, including the northern plain between the Atlantic Ocean and the Massif du Nord, the Artibonite Plain to the north of Chaîne de Mateaux, the cul-de-sac between the Chaîne de Mateaux and Massif de la Selle, and the Central Plateau to the east of the Montagnes Noires.

Haiti once was covered with tropical rain forest and Caribbean pine, but the country has been subjected to extensive clearing of its woodlands for farming and provision of timber and firewood which has resulted in serious erosion problems. About 880,800 hectares (2.2 million acres) of land remain arable.

The mountains that divide Haiti and the Dominican Republic block the moist north and east trade winds of the Caribbean, producing a semiarid climate in Haiti. Typically, the highlands receive more precipitation than the plains, and the north and east facing slopes receive generous precipitation. The seasonal incidence of rain varies by locality, and total annual rainfall may be 20 in (51 cm) to more than 100 in (254 cm). Near the northern coast there is more rain in winter than summer, but farther south winter is a relatively dry season. April through June and September through November are the primary rainy seasons.

The main population centers are warm, ranging annually from 70 °F to 90°F (21°C to 32°C). Highest temperatures occur from June through September and lows occur from February through April. Frost frequently occurs during the cool season at elevations above 1300 ft (400 m). Relative humidity is high in coastal areas, often exceeding 70%. Hispaniola also is subject to seasonal tropical storms and hurricanes.

More than 100 small streams drain Haiti's land area. However, the largest river, the Artibonite, is navigable for only a few miles where it is tidal. The total length of this river system is 145 mi (245 km), and its watershed occupies almost one-third of the country. A few shorter rivers in various parts of Haiti maintain steady flow throughout the dry seasons. Practically all coastal streams are blocked at the mouth by sand or gravel deposited by waves and wind. The resulting lagoons offer ideal breeding places for anopheline mosquitoes. Since the principal human settlements of Haiti are located near the coast in the vicinity of these lagoons, few towns are beyond the flight range of vector mosquitoes.

Haiti has an estimated population of 6.2 million people with a mean population density of 82 people/sq mi (214/sq km), making it one of the most densely populated and poorest countries in the world. The poverty level in Haiti is approximately 75%. Although large concentrations of people reside in coastal cities such as Port-au-Prince and Cap-Haitien, more than 80% of the Haitian population lives in rural areas.

Almost 95% of Haitians are of African descent. The rest of the population is mostly of mixed African-Caucasian ancestry. French is the official language of Haiti, but because the literacy rate is just 42% it is spoken by only about 10% of the people. The majority of the population speaks Creole. Most of the population professes Catholicism, but voodoo practices are widespread. Protestant missionary groups are active in the country. Housing shortages and overcrowding are rampant throughout Haiti. As a result of these stresses and an unstable

political climate, emigration has risen to more than 20,000 persons per year.

Agriculture dominates Haiti's economy, but there has been significant growth of tourism and light manufacturing in recent years. Coffee is the country's main crop and principal export. Other exports include bauxite, light manufactured products, sugar and essential oils. Overall, Haiti has little mineral wealth.

Haiti lacks an effective public health system. Moreover, the country's mountainous terrain isolates large numbers of its rural inhabitants from urban health care services. Sanitation capabilities and practices are largely inadequate, and potable water supplies and water treatment facilities are limited. Groundwater is the most important water source. Approximately 50% of the urban population in Haiti has access to treated water, but the water distribution system is old and poorly maintained. By comparison, less than 30% of the rural population has access to treated water. Public standpipes are the most common means for obtaining treated water.

Municipal sewage systems are not present in Haiti although septic tanks and cesspools are used in more affluent homes. Most sewage flows into surface drains. Pollution of surface waters by raw sewage is a serious problem throughout Haiti. Urban waste collection is inadequate and litter and garbage often are left in the streets. Collected wastes are burned in open pits or dumped into ravines. Indiscriminate use of pesticides has caused serious water and soil contamination problems.

Haiti has a high prevalence of infectious and parasitic diseases. With the exception of malaria, the most serious health hazards are directly or indirectly related to poor nutrition and poor personal hygiene. At one time or another, malaria has afflicted nearly three-quarters of the population living in malarious areas, which originally included all territory below elevations of 1650 ft (503 m). Mortality is particularly high among infants and small children.

Tuberculosis ranks with malaria and malnutrition among the most serious of health hazards because of crowded and unsanitary housing conditions; malnutrition and inadequate medical care have compounded the problem. Yaws once rivaled malaria in its severity as a health hazard, but it has been virtually eliminated.

Parasitic infections are common among children and adults alike. Roundworms and pinworms are especially common. Typhoid fever is endemic to Haiti, and epidemics occur frequently during the dry months. Yellow fever has not been reported from Hispaniola since the 1930s. Dengue fever appears frequently, particularly in the vicinity of Cap-Haitien.

The presence of brucellosis and bovine tuberculosis in cattle and tapeworm infestations among pigs make thorough cooking of meat essential. Pasteurized milk is available in Port-au-Prince, but even in this city milk should be sterilized before use. Haiti has many open-air markets which are crowded and unsanitary. Vegetables obtained from such sources should be washed in chlorinated water and cooked, and fruits should be washed and peeled before eating. Haiti has the highest sero-prevalence of HIV among Latin American and Caribbean nations. Appropriate precautions should be exercised for preventing sexually transmitted diseases.

MILITARILY IMPORTANT VECTOR-BORNE DISEASES

MALARIA

INFECTIOUS AGENTS: *Plasmodium falciparum*, *Plasmodium malariae*, *Plasmodium vivax*

EPIDEMIOLOGY: Malaria is endemic to Haiti, and all areas below elevations of 1650 ft (503 m) are malarious. Haiti has the highest malaria case rate among West Indies nations and is among the most malarious countries in the Western Hemisphere. The World Health Organization lists all areas of Haiti including urban ones as malarious. In 1984, an estimated 55,000 cases of malaria occurred in Haiti, but in recent years (1988-present) there has been an overall decline in reported malaria cases. The principal species involved is *P. falciparum*, accounting for nearly 99% of reported cases. All strains so far have been shown to be chloroquine sensitive, but resistance to pyrimethamine has been demonstrated. Travelers to Haiti should receive malaria chemoprophylaxis. Reported malaria cases typically peak 3-4 months following the rainy season (November-January) or approximately 3 months after mosquito densities peak.

VECTOR TRANSMISSION:

Primary Vector: *Anopheles albimanus*

Secondary Vector: *An. pseudopunctipennis*

VECTOR BIONOMICS: *Anopheles albimanus* larvae live in a great variety of sunlit aquatic habitats. The most common breeding sites are large ponds, lakes, seepages, irrigation ditches and rice fields. Although typically an inhabitant of fresh water, this species can tolerate moderate salinity and thus may be found in brackish water or estuaries that are periodically flooded from tidal action. *Anopheles albimanus* breeds chiefly during periods of heaviest rain, but in most areas breeding is continuous year-round. Normally, the life cycle is completed in 2-3 weeks. Adults begin feeding at sundown and bite throughout the night, although biting peaks during the first 3 hours after sunset. Adults are strongly exophilic (prefer outdoors) and this behavior could decrease the effectiveness of spraying houses and other buildings with residual insecticides. *Anopheles pseudopunctipennis* is found in both exo- and endophilic biting situations, and it is an excellent vector of malaria in some areas of Central America.

DENGUE FEVER

INFECTIOUS AGENT: Group B Flavivirus

EPIDEMIOLOGY: The current status of dengue fever in Haiti is essentially unknown. It's likely that no reporting system for dengue illness in the country exists. The Pan American Health Organization (PAHO) has requested but hasn't received any information on dengue or dengue hemorrhagic fever in Haiti since 1988.

Dengue fever is endemic and viral serotypes 1,2,3 and 4 have been isolated. Caribbean Basin countries are also at risk for outbreaks of dengue hemorrhagic fever. Incidence of dengue fever in the Americas,

as well as the number of circulating serotypes, has been increasing in recent years. In 1984, 328 confirmed cases were reported from Haiti, including the capital Port-au-Prince. In previous outbreaks, proportions of people testing positive for dengue fever have been as high as 59%.

VECTOR TRANSMISSION:

Primary Vector: *Aedes aegypti*

Secondary Vector: *Ae. mediovittatus*

VECTOR BIONOMICS: *Aedes aegypti* is often associated with human activity. This species will breed in artificial containers (cisterns, rain barrels, tin cans, and discarded tires) as well as natural cavities (treeholes and certain plants). Eggs hatch in about 4 days and the life cycle is completed in 10-18 days. *Aedes aegypti* breeds year-round in Haiti. Destruction of breeding habitat is the best means of controlling this species. *Aedes aegypti* is diurnally active and feeds on man and other animals indoors and out. The bionomics of *Ae. mediovittatus* are similar to those of *Ae. aegypti*. Note: *Ae. albopictus*, a potential dengue vector recently introduced into the Americas from Asia, was seen in the Dominican Republic in 1993.

BANCROFTIAN FILARIASIS

INFECTIOUS AGENT: *Wuchereria bancrofti* (nematode)

EPIDEMIOLOGY: Bancroftian filariasis is found mainly in the cities of northern Haiti. Cases have been reported from Limbe, Les Cayes, Cap-Haitien, Port Margot, Plaisance, Gonaives and other urban areas. This disease is most prevalent in areas where socioeconomic and sanitary conditions are poor. A survey for *W. bancrofti* in Limbe during 1983 revealed that 17% of people surveyed were infected, and 20% of the *Cx. quinquefasciatus* examined harbored the parasite. However, the parasite persists in Haiti only in localized foci, primarily around urban centers of the Gulf of Gonave and the Departement du Nord. The parasite shows marked nocturnal microfilarial periodicity associated with feeding mosquito vectors. Man is the only known definitive host. Prevention is mainly through mosquito control and use of mosquito netting and repellents for personal protection.

VECTOR TRANSMISSION:

Primary Vector: *Culex quinquefasciatus*

Secondary Vector: *Aedes aegypti*

VECTOR BIONOMICS: *Culex quinquefasciatus* lays egg rafts in rain barrels, water tanks, cisterns, and temporary pools, but water having a high organic content is preferred. Large populations of this species are common in urbanized areas. Adults of *Cx. quinquefasciatus* feed primarily at night both indoors and out. They readily bite humans but prefer birds.

MANSONELLOSIS (FILARIASIS)

INFECTIOUS AGENT: *Mansonella ozzardi* (nematode)

EPIDEMIOLOGY: Mansonellosis is endemic to tropical areas of Central and South America and the Caribbean. In Haiti, this parasitic nematode is primarily found in coastal regions, especially coastal mangrove swamp communities.

VECTOR TRANSMISSION:

Primary Vectors: *Culicoides furens*, *C. barbosai*

Secondary Vectors: *Culicoides phlebotomus* (in Trinidad), black flies

VECTOR BIONOMICS: Larvae of *C. furens* inhabit coastal sand and inland brackish water. Sometimes they are found in freshwater mud. This species breeds along much of Haiti's coastline, especially in areas of tidal mangrove swamps. Adults of *C. furens* usually bite on the lower legs, whereas a secondary vector, *C. barbosai*, most often bites the arms and head.

LOUSE-BORNE TYPHUS

INFECTIOUS AGENT: *Rickettsia prowazekii*

EPIDEMIOLOGY: Infected lice are transferred from person to person. People are infected through rubbing or crushing lice or louse feces into bite wounds or abrasions. Without treatment, fatality can be high, varying from 10-40% in epidemics. Humans are the reservoir.

VECTOR TRANSMISSION:

Primary Vector: *Pediculus humanus humanus*

Secondary Vector: *Pediculus humanus capitis*

VECTOR BIONOMICS: Louse infestations occur under conditions of crowding and deprivation. Poor personal hygiene, such as not washing the body, hair and clothing, creates ideal conditions for lice. Close interpersonal contact among infested individuals facilitates louse transfer. Massive outbreaks are common under wartime conditions, particularly among refugees and prisoners.

DIARRHEAL DISEASES

INFECTIOUS AGENTS: Pathogens include bacteria (*Aeromonas* spp., *Campylobacter* spp., *Escherichia coli*, *Salmonella* spp., *Shigella* spp., *Vibrio* spp.) and Protozoa (*Cryptosporidium* spp., *Entamoeba histolytica*, *Giardia lamblia*, *Iodamoeba butschlii*).

EPIDEMIOLOGY: Diarrheal diseases are prevalent throughout Haiti.

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

PRIMARY VECTORS: *Musca domestica* and other flies associated with human activity

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

OTHER VECTOR-BORNE DISEASES OF POTENTIAL MILITARY IMPORTANCE

EASTERN EQUINE ENCEPHALITIS

INFECTIOUS AGENT: Group A Alphavirus

EPIDEMIOLOGY: Small outbreaks of EEE have occurred in the Dominican Republic. Man and horses are accidental hosts and produce viremias too low to infect mosquitoes. EEE manifests itself clinically in horses, producing high mortality. Epizootics in horses often precede occurrence of human cases. Outbreaks of human cases are small, usually involving less than 100 cases. A variety of bird species serve as reservoirs and amplifying hosts. This inflammatory viral disease has a case fatality rate that can approach 60%. The elderly and children are most susceptible to infection.

VECTOR TRANSMISSION:

Primary Vectors: *Culex nigripalpus*, *Aedes taeniorhynchus*

VECTOR BIONOMICS: *Culex nigripalpus* breeds in a broad variety of aquatic habitats including lakes, temporary pools, epiphytic plants, brackish water, and artificial containers. It is an omnivore, feeding mainly on birds and mammals, including humans. This species is nocturnally active with a peak biting period during evening twilight. It is primarily an exophilic species but also will enter houses. *Aedes taeniorhynchus* breeds in coastal and inland saline waters. It is a fierce biter by day of any warm-blooded animal, especially humans. Large migratory flights of this species are preceded by highly synchronous development.

ST. LOUIS ENCEPHALITIS

INFECTIOUS AGENT: Group B Flavivirus

EPIDEMIOLOGY: SLE virus has been isolated from pools of Haitian mosquitoes. However, human outbreaks of this disease are not known outside the U.S., where major epidemics involving several thousand cases have occurred periodically. The number of inapparent infections with this disease is much higher than the number of recognized clinical cases. Birds are the primary amplifying hosts, but infection is asymptomatic in birds. Man is an accidental host and plays no role in the transmission of the disease.

VECTOR TRANSMISSION:

Primary Vectors: *Culex quinquefasciatus* and *Cx. nigripalpus*; both species are primary vectors in the U.S., and both species are found in Haiti.

Secondary Vector: *Sabethes bipartipes*

VECTOR BIONOMICS: *Culex quinquefasciatus* lays egg rafts in rain barrels, water tanks, cisterns, and temporary pools. Water having a high organic content is preferred. Large populations of this species are

common in urbanized areas. Adults feed primarily at night both indoors and out. They readily bite humans but are primarily bird feeders. See eastern equine encephalitis for information on *Cx. nigripalpus*.

LEISHMANIASIS

INFECTIOUS AGENT: *Leishmania mexicana* complex

EPIDEMIOLOGY: A few cases of diffuse cutaneous leishmaniasis have been reported from the Dominican Republic. Although no cases have yet been reported from Haiti, there is a possibility that this disease may occur there, particularly in rural areas.

VECTOR TRANSMISSION:

Primary Vectors: phlebotomine sandflies; species unknown

VECTOR BIONOMICS: unknown

YAWS

INFECTIOUS AGENT: *Treponema pallidum*

EPIDEMIOLOGY: Predominantly a disease of children in tropical countries, particularly in rural areas. Worldwide incidence of this disease has decreased dramatically through mass penicillin treatment campaigns initiated during the 1950s and 1960s. However, scattered foci still exist in the Caribbean region, Latin America, Asia, and West Africa. Although yaws has apparently been eradicated from Haiti, it could be re-established from other foci. Humans and other higher primates are reservoirs.

VECTOR TRANSMISSION:

Primary Vectors: This disease is acquired primarily through contact with infected persons, but indirect transmission may occur through contaminated flies visiting open wounds.

VECTOR BIONOMICS: Not applicable.

DERMAL MYIASIS

EPIDEMIOLOGY: Larvae of the human bot fly, *Dermatobia hominis*, invade intact tissue and cause burrows, or boil-like swellings in the dermal layers with a small opening to the exterior for respiration. Infestations are self-limiting but may cause emotional distress to the victim.

VECTOR TRANSMISSION:

Primary Vector: *Dermatobia hominis*

VECTOR BIONOMICS: Adult female flies attach their eggs to blood-sucking flies and mosquitoes. Larvae hatch and drop off onto the vertebrate host as the carrier feeds. The larvae then burrow into the host's skin, often through the wound made by the feeding carrier. The last larval instar, upon completing growth, exits the host and pupates in soil.

SUBDERMAL MYIASIS (SCREWORM)

EPIDEMIOLOGY: Screwworms are obligate wound infesting flies that may parasitize humans. The female fly lays eggs in wounds in the host's tissues. Serious human infestations can result from only minor wounds, including those to the sinuses and ano-genital area. Invasion of the brain may result in death.

VECTOR TRANSMISSION:

Primary Vector: *Cochliomyia hominivorax*

VECTOR BIONOMICS: Adult female flies are attracted to host wounds, even minor ones, and/or infected areas where eggs are laid. Larvae hatch and begin feeding on the victim's flesh.

MURINE TYPHUS

INFECTIOUS AGENT: *Rickettsia typhi*

EPIDEMIOLOGY: Infective fleas defecate rickettsiae during feeding, thus contaminating the bite site. This disease occurs worldwide. Symptoms resemble those of louse-borne typhus but are much milder. Fatality rate is usually less than 2%. Rats, mice and other small animals are reservoirs. Infection is inapparent among reservoir animals.

VECTOR TRANSMISSION:

Primary Vector: *Xenopsylla cheopis*

Secondary Vectors: *Ctenocephalides felis*; possibly other species of fleas and lice

VECTOR BIONOMICS: Zoonotic infections are maintained in nature through a rat-flea-rat cycle. Fleas, once infected, apparently remain so for life. Other species of fleas and possibly lice and some mites also may be vectors. However, these animals are killed by the *Rickettsia*, suggesting they play only a minor role, if any, in transmission.

SCHISTOSOMIASIS

INFECTIOUS AGENT: *Schistosoma mansoni* (trematode)

EPIDEMIOLOGY: There have been no reported cases of schistosomiasis in Haiti, but the proximity of endemic areas in the Dominican Republic, coupled with the frequency of border crossings by Haitian agricultural workers, is cause for concern. Eggs in human feces hatch in water, yielding miracidia (larvae) that infect suitable freshwater snails. The miracidia undergo transformation in their snail intermediate hosts, producing free swimming cercariae, which readily penetrate unbroken skin. The spread of schistosomiasis is favored by poor sanitation which allows contamination of water with feces containing eggs. Animal reservoirs are not a significant source of infection.

VECTOR TRANSMISSION:

Intermediate Hosts: *Biomphalaria glabrata*, *B. havanensis* (snails)

INTERMEDIATE HOST BIONOMICS: *Biomphalaria glabrata* and *B. havanensis* are intermediate hosts for *S. mansoni*. Both species have been found in nature to contain sporocysts of *S. mansoni*. If *S. mansoni* carriers were introduced into areas of Haiti where these snails occur, the potential for an outbreak would be significant. Both species have widespread but discontinuous distributions in swamps between Plaine de Nord and Cap-Haitien in the Departement du Nord, Saint Michel and Bois d'Eau, and on the eastern flood plain of the Riviere du Port Margot, which is under rice cultivation.

LEPTOSPIROSIS

INFECTIOUS AGENT: *Leptospira interrogans*, over 200 serovars are known to exist.

EPIDEMIOLOGY: This disease occurs in both rural and urban environments, and it is particularly common among people who work outdoors. The case fatality rate is usually less than 20%. Reservoirs include numerous wild and domestic animals, reptiles and amphibians. Transmission is effected through pathogen contact with skin and mucous membranes (especially if these are cut or abraded) via contaminated food or water, moist soil, vegetation, the urine or tissues of infected animals or, rarely, aerosols.

RABIES

INFECTIOUS AGENT: *Lyssavirus* spp.

EPIDEMIOLOGY: Rabies occurs worldwide with an estimated 30,000 deaths annually. It is prevalent throughout Haiti. The disease is transmitted primarily through the saliva of rabid animals via bites and scratches. Any mammal, domestic or wild, can serve as a reservoir. All animal bites or scratches received in Haiti should be treated as though infective, particularly if the offending animal is not captured for examination.

APPENDIX A. MOSQUITOES OF HAITI

Those species found in the Dominican Republic but not yet reported from Haiti are indicated by an asterisk (*).

<i>Aedes aegypti</i>	<i>Cx. secutor</i>
<i>Ae. albonotatus</i>	
<i>Ae. busckii*</i>	<i>Deinocerites cancer</i>
<i>Ae. hemisurus</i>	
<i>Ae. mediovittatus</i>	<i>Limatus hoffmani</i>
<i>Ae. pertinax</i>	
<i>Ae. scapularis</i>	<i>Orthopodomyia signifera</i>
<i>Ae. serratus</i>	
<i>Ae. sollicitans</i>	<i>Psorophora cingulata</i>
<i>Ae. taeniorhynchus</i>	<i>Ps. confinnis</i>
<i>Ae. tortilis</i>	<i>Ps. ferox</i>
	<i>Ps. infinis</i>
<i>Anopheles albimanus</i>	<i>Ps. insularia</i>
<i>An. argyritarsis</i>	<i>Ps. jamaicensis</i>
<i>An. crucians*</i>	<i>Ps. johnstonii</i>
<i>An. grabhamii</i>	<i>Ps. pygmaea</i>
<i>An. pseudopunctipennis*</i>	
<i>An. vestitipennis</i>	<i>Sabethes bipartipes</i>
<i>Culex atratus</i>	<i>Toxorhynchites guadeloupensis</i>
<i>Cx. bahamensis</i>	<i>Tx. portoricensis</i>
<i>Cx. bisulcatus*</i>	
<i>Cx. carcinophilus</i>	<i>Uranotaenia cooki</i>
<i>Cx. corniger</i>	<i>Ur. lowii</i>
<i>Cx. duplicator</i>	<i>Ur. sapphirina</i>
<i>Cx. erraticus</i>	<i>Ur. socialis</i>
<i>Cx. habilitator</i>	
<i>Cx. inhibitor</i>	<i>Wyeomyia medioalbipes*</i>
<i>Cx. janitor</i>	<i>Wy. mitchelli</i>
<i>Cx. nigripalpus</i>	<i>Wy. ulocoma*</i>
<i>Cx. quinquefasciatus</i>	<i>Wy. vanduzeei</i>

APPENDIX B. CULICOIDES OF HAITI

<i>Culicoides barbosai</i>	<i>C. insignis</i>
<i>C. borinqueni</i>	<i>C. jamaicensis</i>
<i>C. eadsi</i>	<i>C. phlebotomus</i>
<i>C. foxi</i>	<i>C. pusillus</i>
<i>C. furens</i>	<i>C. trinidadensis</i>

APPENDIX C. OTHER FLIES OF POTENTIAL MEDICAL IMPORTANCE

CALLIPHORIDAE: *Cochliomyia hominivorax*

MUSCIDAE: *Musca domestica*

CUTEREBRIDAE: *Dermatobia hominis*

SARCOPHAGIDAE: miscellaneous species

APPENDIX D. Other Arthropods of Potential Medical Importance

Fleas: *Ctenocephalides felis*
Xenopsylla cheopis

A. albopictum
Anocentor nitens
Boophilus microplus
Ornithodoros puertoricensis
Rhipicephalus sanguineus

Lice: *Pediculus humanus humanus*
P. humanus capitis
Pthirus pubis

Bugs: *Cimex hemipterus*
C. lectularius
Triatoma rubrofasciata

Mites: *Sarcoptes scabiei*
Scorpions: *Tityus crassimanus*

Spiders: *Loxosceles* spp., brown recluse
Latrodectus spp., black widow

Ticks: *Amblyomma cajennense*

APPENDIX E. PERSONAL PROTECTIVE MEASURES

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

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

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

Newly developed repellents provide personnel with unprecedented levels of protection. An aerosol formulation of permethrin (NSN 6840-01-278-1336) can be applied to the uniform but not the skin

according to label directions. This will provide the uniform material with both repellent and insecticidal properties that will be retained through five washings.

An Individual Dynamic Absorption Application (IDAA) kit is also available for the permethrin treatment of uniforms (NSN 6840-01-345-0237). This product enables an individual to treat one uniform and includes two tubes of permethrin, two treatment bags, two pieces of twine, one pair of gloves, and a black marking pen.

A 40% permethrin emulsifiable concentrate (EC) (NSN 6840-01-334-2666) is available for treating uniforms, netting and tentage using a 2-gallon sprayer.

A new extended-duration repellent lotion of DEET (N, N diethyl-3-methyl-benzamide, formerly N, N-diethyl-m-toluamide) (NSN 6840-01-284-3982) has been developed to replace the 2 oz. bottles of 70% DEET in alcohol. The new formulation contains 34% active ingredient. It's less irritating to skin, has less odor, and is generally more acceptable to the user.

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

APPENDIX F. CHEMICAL CONTROL OF PESTS AND VECTORS

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

APPENDIX G. RESISTANCE TO PESTICIDES

Only limited pesticide resistance testing has been accomplished on vector populations in Haiti. However, *Anopheles albimanus* has shown reduced susceptibility to dieldrin and fenitrothion. This species also shows low sensitivity to DEET, which may provide protection for only 4 hours before a reapplication is required. The levels of known resistance to pesticides among mosquito populations in Haiti are not likely to cause control failures.

APPENDIX H. POISONOUS SNAKES OF HAITI

No dangerous species of snakes occur in Haiti. However, four species of arboreal vine snakes (*Uromacer* spp.) are considered to be mildly venomous. They pose little threat to people.

SELECTED REFERENCES

- Acha, P. N. 1980. From concepts to programs: three decades of progress for veterinary public health and animal health in Latin America and the Caribbean. *Bull. PAHO*. 14:356-375.
- Armed Forces Medical Intelligence Center. 1994. Disease and environmental alert report, Haiti. Diseases of operational importance.
- Armed Forces Medical Intelligence Center. 1993. Disease and environmental alert report, Haiti. Environmental health risks of operational importance.
- Armed Forces Pest Management Board. 1991. Contingency pest management pocket guide, 4th ed.
- Belkin, J. N. , R. X. Schick and S. J. Heinemann. 1965. Mosquito studies (Diptera, Culicidae). V. Mosquitoes originally described from Middle America. *Contrib. Am. Entomol. Inst.* 1:1-95.
- Belkin, J. N. and S. J. Heinemann. 1975. Collection records of the project "Mosquitoes of Middle America." Bahama Is. (Bah), Caymann Is. (Cay), Cuba (Cub), Haiti (Hac, Har, Hat) and Lesser Antilles (Lar). *Mosq. News* 7:367-393.
- Benenson, A. S. (ed.). 1990. Control of communicable diseases in man, 15th ed. American Public Health Association, Washington, DC 532 pp.
- Bonnlander, H., A. M. Rossignol and P. A. Rossignol. 1994. Malaria in central Haiti: a hospital-based retrospective study, 1982-1986 and 1988-1991. *Bull. PAHO* 28:9-16.
- Breeland, S. G. 1980. A bibliography to the literature of *Anopheles albimanus* (Diptera: Culicidae). *Mosq. Sys.* 12:50-149.
- Butler, J. F., D. D. Wilson, G. I. Garriss, H. G. Koch, J. M. Crum and V. E. Castellanos. 1985. Survey for potential soft tick (Acari: Argasidae) vectors of African swine fever on the island of Hispaniola. *Exp. Appl. Acarol.* 1:63-72.
- Evans, S.R. 1991. Personal protective techniques against insects and other arthropods of military significance. Entomological Sciences Division, US Army Environmental Hygiene Agency, Aberdeen Proving Ground, MD.
- Focks, D.A. 1994. An assessment of risk of dengue infections in Haiti. USDA, ARS, MAVERL, Gainesville, FL,
- Herip, D. S. and D. D. Slaten. 1992. Preventive medicine at the Haitian refugee camps. *Navy Medicine*, March-April. pp. 3-7.
- Hobbs, J. H., J. D. Sexton., Y. St. Jean and J. R. Jacques. 1986. The biting and resting behavior of *Anopheles albimanus* in northern Haiti. *J. Am. Mosq. Control Assoc.* 2:150-153.
- Lampe, K. F. and M. A. McCann. 1985. AMA handbook of poisonous and injurious plants. American Medical Association, Chicago. 432 pp.
- Laroche, V. 1965. Human leptospirosis in Haiti. *Bol. Ofici. Sanit. Panamer.* 59:414-422.
- Lowrie, R. C., Jr. and C. P. Raccurt. 1981. *Mansonella ozzardi* in Haiti. II. Arthropod vector studies. *Am. J. Trop. Med. Hyg.* 30:598-603.
- Lowrie, R. C., Jr. and C. P. Raccurt. 1984. Assessment of *Culicoides barbosai* as a vector of *Mansonella ozzardi* in Haiti. *Am. J. Trop. Med. Hyg.* 33:1275-1277.
- Mason, J. 1968. Development of the Haiti Malaria Eradication Programme. World Health Organization/MAL/68.665. 22 pp.
- Mason, J. and P. Cavale. 1965. Malaria epidemic in Haiti following a hurricane. *Am. J. Trop. Med. Hyg.* 14:533-539.
- Michelson, E. H. 1976. A potential intermediate host of *Schistosoma mansoni* from Haiti. *J. Parasitology* 62:648-649.

- Miller, M. J., R. C. Ratard, and D. F. McNeeley. 1976. Filariasis in Haiti. *J. Parasitology* 62:845-847.
- Morel, P. C. 1967. Les tiques des animaux sauvages des Antilles (Acariens, Ixodoidea). *Acarologia* 9:341-352.
- Navy Disease Vector Ecology and Control Center, Jacksonville. 1993. Haiti - vector risk assessment profile.
- Navy Environmental and Preventive Medicine Unit #2. 1993. Disease risk assessment profile: Haiti.
- Porter, J. E. 1967. A checklist of the mosquitoes of the Greater Antilles and the Bahama and Virgin Islands. *Mosq. News* 27: 35-41.
- Raccurt, C. P. 1986. *Toxoplasma gondii* en Haiti. *Bull. Soc. Path. Ex.* 79:721-729.
- Raccurt, C. P. 1986. La filariose lymphatique en Haiti: sequelles historique ou probleme d'avenir pour la sante publique a l'echelon regional? *Bull. Soc. Path. Ex.* 79:745-754.
- Raccurt, C. P. and W. Hodges. 1977. Filariasis due to *Wuchereria bancrofti* in Haiti. *Trans. Royal Soc. Trop. Med. Hyg.* 71: 452-453.
- Raccurt, C. P., R. C. Lowrie, Jr., S. P. Katz and Y. T. Duverseau. 1988. Epidemiology of *Wuchereria bancrofti* in Leogane, Haiti. *Trans. Royal Soc. Trop. Med. Hyg.* 82:721-725.
- Raccurt, C. P., M. Mojon and W. H. Hodges. 1984. Parasitological, serological, and clinical studies of *Wuchereria bancrofti* in Limbe, Haiti. *Am. J. Trop. Med. Hyg.* 33:1124-1129.
- Raccurt, C. P., W. A. Sodeman, Jr., G.L. Rodrick and W.P. Boyd. 1985. *Biomphalaria glabrata* in Haiti. *Trans. R. Soc. Trop. Med. Hyg.* 79:455-457.
- Rankin, S. E., M. D. Zyzak, J. L. Burch and S. J. Claus. 1992. U.S. Navy entomology involvement in Haitian migrant operations. 63:91-94.
- Ripert, C., C. P. Raccurt and P. L. Douyon. 1977. Epidemiological aspects of *Mansonella ozzardi* filariasis in Haiti (Greater Antilles). *Bord. Med.* 10:689-696.
- Ryckman, R. E., D. G. Bentley and E. F. Archbold. 1981. The Cimicidae of the Americas and oceanic islands, a checklist and bibliography. *Bull. Soc. Vector Ecol.* 6:93-142.
- Ryckman, R. E. 1984. The Triatominae of North and Central America and the West Indies: a checklist with synonymy (Hemiptera: Reduviidae: Triatominae). *Bull. Soc. Vector Ecol.* 9:71-83.
- Schnur, L. F., B. C. Walton and H. Bogaert-Diaz. 1983. On the identity of the parasite causing diffuse cutaneous leishmaniasis in the Dominican Republic. *Trans. Royal Soc. Trop. Med. Hyg.* 77:756-762.
- Stahnke, H. L. 1972. A key to the genera of Buthidae (Scorpionida). *Entomol. News* 83:121-133.
- Taylor, R. T. 1966. The ecology of *Anopheles albimanus* (Wied.) in Haiti. *Mosq. News* 26:393-396.
- Ventura, K. A. and N. J. Ehrenkranz. 1976. Endemic dengue fever virus infection in Hispaniola. I. Haiti. *J. Infect. Dis.* 134:436-441.
- Wirth, W. W. and F. S. Blanton. 1974. The West Indian sandflies of the genus *Culicoides* (Diptera: Ceratopogonidae). *USDA Agric. Res. Serv. Tech. Bull. No. 1474.* 98 pp.