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Manual of Naval Preventive Medicine

Chapter 8
Navy Entomology and Pest Control Technology

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Table of Contents

CHAPTER 8

MEDICAL ENTOMOLOGY AND PEST CONTROL TECHNOLOGY

Sections

Section I. NAVY ORGANIZATION FOR MEDICAL ENTOMOLOGY PROGRAMS

8-1. Definition of Vector

(1) The term vector refers to organisms, primarily arthropods and rodents, which play a significant role in the transmission of disease to man, act as intermediate hosts or reservoirs of disease, present problems of sanitary or hygienic significance, or otherwise affect the health and efficiency of personnel. Included are arthropods such as mosquitoes, biting flies, filth and flesh flies, lice, bed bugs, reduviid bugs, fleas, mites, ticks and mammalian pests such as rodents and bats. Cockroaches, ants, wasps, spiders, scorpions and food infesting insects are pestiferous arthropods not ordinarily associated with specific diseases, but may be considered as vectors whenever the medical department finds that they present problems of sanitary or morale-affecting significance.

(2) Organisms destructive to structures, stored products, grounds, and other material properties are classified as "economic pests." In addition to the vector pests described above, the definition of pests in this Chapter also includes those which are objectionable because of their presence. For information on economic pests, as well as for additional vector species, refer to the Armed Forces Pest Management Board publication, "Military Entomology Operational Handbook."

8-2. Policies for Pest Control

(1) Department of Defense (DoD) Directive 4150.7 series provides basic standards and policies governing the Navy's pest control programs. This directive establishes minimum levels of pest control for DoD installations and program policies for pest management implementation.

(2) Chief of Naval Operations (OPNAVINST) Instruction 6250.4 and OPNAVINST 5090.1 outline pest control responsibilities and functions of the offices and commands of the Department of the Navy and establish policies to provide maximum effectiveness, efficiency, and safety in pest control operations.

(a) *Shore Activities*- Commanders of all shore activities of the Department of the Navy bear the basic responsibility for the maintenance of an adequate vector and economic pest control program. This responsibility is normally delegated to the medical and public works departments. The public works department is required to conduct pest control operations as a scheduled part of performed services. The medical department is required to plan and recommend vector control measures and to determine that all pesticides are applied safely. Joint planning of the activity's past control program by the public works and medical departments is necessary to ensure maximum effectiveness, efficiency and safety.

(b) *Commands Afloat*- Commanders afloat are assigned responsibility of maintaining effective and safe shipboard pest control programs. Naval Medical Command (NAVMEDCOM) Instruction 6250 series delegates the responsibility for supervising pest control operations to the medical department.

(c) Technical Responsibilities-The Naval Facilities Engineering Command (NAVFACENGCOM) is responsible to provide technical guidance, program assis-

tance, and personnel training to Navy and Marine Corps activities, maintain regional training and recertification programs in cooperation with NAVMEDCOM for civilian pesticide applicator (pest controller) personnel, and provide training and certification programs for pest control quality assurance evaluators (QAE).

8-3. Specific Responsibilities of the Medical Department

(1) Specifically, the medical department is responsible to the commanding officer for

(a) Inspections and surveys to determine the species, source, location and density of vectors.

(b) Recommendations relating to sanitation standards and practices affecting the presence and abundance of vectors and utilization of vector control methods.

(c) Evaluation of the effectiveness of vector control measures.

(d) Inspections and recommendations to ensure that pesticides are used safely in accordance with current directives.

(e) Provide information on all appropriate personal protective measures against vectors.

(f) Coordination with civilian and other governmental agencies having vector control problems that may affect naval personnel on or in the vicinity of a command.

(g) Compliance with all appropriate public health quarantine measures.

(h) Reviewing and approving activity pest management plans.

(2) The medical department may be additionally charged by the commanding officer with the responsibility for all operational phases of the vector control program as follows:

(a) In the event of a vector-borne disease outbreak.

(b) In the absence of a public works department, such as at certain shore installations, on board ships and with troops in the field.

(c) In the control of vectors actually infesting humans (e.g., lice, mites).

(d) In disasters.

8-4. Location and Responsibilities of Navy Medical Entomologists

(1) Operational Navy medical entomologists are assigned to Disease Vector Ecology and Control Centers (DVECC) at Naval Air Stations (NAS), Jacksonville, Florida and Alameda, California. Medical Entomologists are also assigned to the Environmental and Preventive Medicine Units (EPMU) in Norfolk, VA (No. 2); San Diego, CA (No. 5); Pearl Harbor, HI (No. 6); and Naples, Italy (No. 7); to the Preventive Medicine Section, 1st FSSG, Camp Pendletan, CA; 2nd FSSG, Camp Lejeune, NC; and 3rd FSSG, Okinawa, Japan; and the Occupational and Preventive Medicine Department, U.S. Naval Hospital, Subic Bay, Philippines.

(2) Navy medical entomologists assigned research responsibilities may also be assigned to the Naval Medical Research Units.

(3) Medical entomologists at DVECC and EPMU locations, when authorized by proper authority, may conduct vector control operations for the purpose of training personnel; field testing new methods, materials and equipment; or providing area-wide vector control services that involve the use of specialized equipment.

(a) The DVECC, NAS, Jacksonville, FL area of assignment includes all activities under Commander in Chief, Atlantic Fleet; Commander in Chief, U.S. Naval. Forces, Europe; and includes 100W longitude east to 70E longitude.

(b) The DVECC, NAS, Alameda, CA is responsible for all activities under the Commander in Chief, Pacific Fleet and includes 100W longitude west to 70E longitude.

(4) Functions of DVECC medical entomologists include:

(a) Survey ships, stations and other pertinent operational areas for the purpose of recognizing, defining and preventing or abating vector or ecological problems associated with pesticide use.

(b) Provide specialized area-wide operational services, which shall include identification of suspected entomological vectors of biological warfare agents and/or material for the control of vectors where accomplishment is normally beyond the scope of individual commands.

(c) Provide basic, advanced and refresher training for military and civilian personnel in vector and economic pest prevention and control measures including integrated pest management strategies.

(d) Provide aid, consistent with the mission and when authorized, in the event of civil emergencies or disasters including environmental contamination resulting from toxic pesticide spills.

(e) Provide review of requisitions for non-standard and controlled issue economic pest and vector control items as established by current directives.

(f) Conduct field and laboratory evaluation and testing studies in vector prevention and control, including aerial and ground pesticide dispersal methods and ecological hazards or pesticide use, when authorized by COMNAVMEDCOM.

(g) Maintain such liaison with governmental and civil agencies as necessary for mission accomplishment.

(h) Provide medical information to requesting commands on vector borne disease occurence worldwide.

(i) Provide or undertake such other appropriate functions as may be authorized or directed by higher authority.

(5) Functions of EPMU medical entomologists, within the primary mission, are the same as those given for DVECC'S subject to the limitations imposed by laboratory facilities and availability of funds.

(6) Special operating units are available as functional components for advanced base use. Entomologists and preventive medicine technicians (PMT) are provided in the Navy advanced base organization.

(7) Entomologists may be assigned as MMART mem-

hers in accordance with COMNAVMEDCOM Instruction 6440.2.

(8) The entomologist assigned to Defense Logistics Agency (DLA) provides specialized support in the area of stored products pest management.

8-5. Specific Responsibilities of Applied Biologists of the Naval Facilities Engineering Command

Specific responsibilities of Applied Biologists assigned to Engineering Field Divisions of the Naval Facilities Engineering Command are delineated in OPNAVINST 6250.4.

8-6. Training and Additional Personnel

(1) *Shipboard Pest Control*

(a) Scheduled training programs are available to shipboard pest control personnel. This training, as required by NAVMEDCOMINST 6250.13 series, presents techniques and precautions necessary to safely apply pesticides aboard ship. The senior enlisted medical department representative and the corpsman responsible for pest control must attend shipboard pest control training once a year.

(b) Only medical department personnel successfully completing the course will be officially certified. Certified personnel are qualified to procure standard stock pesticides approved for use aboard ship and conduct shipboard pest control operations. Other personnel such as those in the supply and food service departments play an important role in a ship's pest control program. They are strongly encouraged to attend this training program.

(2) *Pest Control at Shore Installations*

(a) Pesticide dispersal and other pest control operations must be performed by or under direct and continuing supervision of trained and certified personnel. In accordance with DoD Directive 4150.7, direct supervision includes being at the specific location where the work is conducted and maintaining line of sight view of the work performed; direct supervision is required only during the application of restricted-use or state limited-use pesticides.

(b) Training and certification of public works personnel must follow guidelines set forth in DoD Directive 4150.7-M and 4150.7-R.

(c) Training and certification of medical department personnel assigned responsibilities related to surveillance and control of arthropods and other vectors must follow guidelines set forth in NAVMEDCOMINST 6250.12 series. Personnel frequently assigned pest surveillance and control responsibilities are Environmental Health Officers (EHO) and PMT's.

(d) Specialized vector and pest control training leading to certification is available at both DVECC'S.

8.7 Integrated Pest Control Programs and Pest Management

(1) OPNAVINST 6250.4 series states that naval shore activities will cooperate with federal, state and local environmental protection agencies and comply with the official standards and criteria promulgated by such agencies. Naval ships in foreign harbors and naval installations overseas will cooperate with foreign host nations and, to the extent practicable, provide pollution abatement measures equal in degree and timing to those of the host nations.

(2) Public concern over extensive use of long lasting pesticides and their possible effects on human health, wildlife resources and other elements of the environment emphasizes the need for continuous professional review and training in the selection and application of pest control measures. The Department of the Navy will continue to support these standards and objectives fully by requiring that all pest control measures be performed under supervision of certified personnel using professionally approved pesticides and equipment.

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Section II. PESTICIDES AND THEIR APPLICATION

8-8. **Definitions of Pesticides**

(1) A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, or any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

(2) Pesticides are used in many ways and include: acaricides, avicides, fungicides, herbicides, insecticides, molluscicides, nematocides, rodenticides, among others. Fumigants are also pesticides and may function as any of the above depending upon the type of formulation, means of application, mode of action, target area, and pest species.

8-9. **Department of Defense Standards**

(1) DoD Components' pest management programs conform to the following requirements. Controlled pesticides are for use by only trained pesticide applicators

and under the onsite supervision of a DoD-certified applicator or by specially trained site or shipboard medical department personnel. All EPA restricted use pesticides may be procured and used only by certified pesticide applicators or by persons under their direct supervision.

(2) Uncontrolled pesticides are also available without control through the military supply system in the DoD section of the Federal Supply Catalog (FSC) Group 68, Chemicals and Chemical products. Where controlled or uncontrolled items do not provide satisfactory control *or* when there is any doubt that available personnel are qualified to supervise the application of any pesticide, medical officers should request the help of specialists. Entomologists of the medical department and applied biologists of NAVFAC, Articles 8-4 and 8—5 respectively, will provide services necessary to survey pest problems, outline control programs, train, and certify local personnel.

(3) Nonstandard pesticides and dispersal equipment must not be used unless approved by the appropriate area entomologist in accordance with current instructions.

8-10 Classification of Pesticides

(1) Pesticides may be classified on the basis of use, life stage of the pest to be controlled, chemical group, mode of entry, mode of action and formulation. Some pesticides are not easily categorized by standard methods because they can be used against two or more groups of pests or in formulations that may have two or more modes of entry or action.

(2) Pesticide type-by use:

(a) Acaricide-a substance used to control mites, scorpions, spiders, ticks and related organisms.

(b) Fungicide—a substance used to control fungi.

(c) Herbicide—a substance used to control u$_n$-desired vegetation.

(d) Insecticide—a substance used to control insects, sometimes used in a broader sense to include the control of arthropods other than insects. Classification of insecticides maybe subdivided on the basis of the life stage against which they are used:

1. Adulticide—used to control the adult stage of an insect.

2. Larvicide-used to control the larval stage of an insect.

3. Ovicide—used against the egg stage of an insect.

(e) Molluscicide—used to control snails and other mollusks.

(f) Rodenticide-used to control rodents.

(3) Pesticide type-by chemical group:

(a) Inorganic pesticides are compounds of mineral origin and mainly include arsenic, copper, mercury, sulfur or zinc.

(b) Chlorinated hydrocarbons are a group of synthetic organic compounds with one or more chlorine atoms. Chlordane, dieldrin, and DDT are examples.

(c) Organophosphates are synthetic compounds containing phosphorous. Some of the more common examples in this group are diazinon, dichlorvos, and malathion.

(d) Carbamates are synthetic compounds of salts or esters of carbamic acid. Carbaryl and propoxur are examples.

(e) Botanical are pesticides of plant origin. Pyrethrums and rotenone are examples. Synthetic pyrethroids, such as resmethrin, are similar in action to pyrethrum. D-phenothrin is another example.

(4) Pesticide type-by mode of entry:

(a) Stomach poisons are materials which kill following ingestion. Application may be directly to the pest's natural food, mixed with baits, or sprinkled in runways so pests will take the compound into the mouth when cleaning contaminated appendages.

(b) Contact poison enter through the insect's body wall or respiratory centers and/or other tissues. They include residual surface sprays that kill pest coming in contact with the treated area and aerosols or space sprays that kill after contact with the body surface. Contact poisons may also act as a stomach poison if ingested.

(c) Fumigants are chemicals that enter in the gaseous or vapor form via the respiratory system and/or through body surfaces.

(5) Pesticide type—by mode of action:

(a) Biological—a pesticide formulation containing parasitic microorganisms such as viruses, bacteria, fungi, protozoans, nematodes, or their products that control the pest.

(b) Desiccants are absorptive dusts which scratch, absorb, or abrade the waxy surface of the exoskeleton causing death by dehydration. Silica gels are examples.

(c) Preservatives are normally poisonous substances applied to materials such as wood to protect from destructive pests.

(d) Repellents are compounds which actively repel pests and, thus, deter attack.

(e) Chemosterilants are substances that chemically sterilize pests, thus, reducing reproductive potential.

(f) Soil sterilants are normally thought of as a herbicide treatment to control unwanted vegetation in a given area for 6 months or more. Some sterilants are specific for soil dwelling animal species. Fumigants in this catagory are often used to control both plant and animal life.

(g) Systemics are compounds absorbed by and translocated throughout the host plant or animal to kill parasites sucking juice or body fluids, respectively. Herbicides may be systemic and kill the treated plant (root and aerial).

(h) Growth regulators are synthetic hormone-like compounds that prevent normal growth of and/or maturity of the target plant or animal species.

8-11. Pesticide Formulation and Dispersal

(1) *General.* Few pesticides are used in the originally produced concentrated forms. Most of these compounds must be specially formulated to permit adequate and effective application. Formulations are prepared from

the highest concentrated (technical-grade) form of the pesticide and may contain auxiliary carrier or dispersal compounds such as emulsifiers, solvents, or other special additives. Virtually all preparation of concentrated material for military use is done commercially. Dilution of the concentrate with oil or water is all that is normally required. Dry dusts or granules are usually prepared in a ready-to-use form and require no further processing.

(2) *Formulation selection.* Selection of the proper formulation for a specific control measure is as important as the choice of pesticide. The various formulations into which pesticides may be prepared are:

(a) *Oil Solutions.* Oil solutions consist of the toxicant mixed into a petroleum based diluent. They are effective for penetrating cracks and crevices. They may be used around electrical equipment or power distribution panels, but the oil must not contact the wiring or insulation because of its solvent properties. These solutions may be used where dampness or water cause problems or where there is a need to apply insecticides in cold weather. Oil solutions are also applied as space aerosols or sprays either indoors or outdoors for knockdown or kill of insects. Space sprays are effective against flying insects only while the particles remain suspended the air. Droplets that settle from spray applications may be effective as short-time residuals depending upon their particle size and insecticide characteristics. It must be remembered that oil solutions are phytotoxic and care must be taken when using them around desired vegetation. Oil solutions cannot be exposed to high temperatures or open flames, and their solvent action precludes their application to some synthetic substances (e.g., composition, fabric or plastic materials). Oil solutions are generally more readily absorbed through the skin and also more odorous than other kinds of preparations.

(b) *Emulsions.* An emulsion consists of droplets of an emulsifiable pesticide dispersed in a diluent in such a way as to prevent separation of the two components. The emulsifiable concentrate is a preparation of the toxicant, a solvent and the emulsifier which is often some form of detergent. Emulsifiable concentrates are almost always diluted with water, but can be diluted with oil to form an oil solution. "Breaking," the gradual separation of the water and other ingredients, occur with time so the preparation must be used when freshly mixed. Occasional agitation may be necessary during use. Emulsions can be used on synthetic organic materials, around heat or open flames and with care on vegetation.

(c) *Suspensions.* Suspensions are generally mixtures of wettable powder with water. The wettable powder consists of a mineral base impregnated with the pesticide plus agents to "wet" and suspend the powder in water. Suspensions must be used with machines that provide constant agitation. Suspensions dispered by a portable compressed sprayer also require frequent agitation. Suspensions are employed as foliage/grass sprays for application against turf pests, as residuals against some stored products pests and for interior residuals in malaria control programs.

(d) *Dusts.* Dust is a mixture of a toxicant plus an inert base usually consisting of a finely ground form of bentonite, pyrophyllite, or talc. These mixtures are used as indoor and outdoor residuals and for animal applications.

(e) *Granules/Pellets.* Granules or pellets are preparations of pesticide impregnated into particles of highly absorptive clays and earths which are graded by sizes ranging from coarse pebble-like pellets to those with a consistency of fine sand. Granules and pellets with greater particle weight have a minimized drift, thus, preventing undesirable contamination of areas bordering those being treated. The most useful size range is from 15 to 40 mesh. An important use of granules for *vector* control is in mosquito larviciding where penetration of foliage and adequate deposit in water is desired. Granules can be applied by large turbine-type dusters, back-pack units, hand-carried dust dispensers and portable seeders. Special aerial dispersal units may also be employed for large area treatment.

(f) *Nonparticle pesticides.* This miscellaneous grouping includes the application of pesticides by brush or roller, as a paste, grease, or cream, or as solid formulations which vaporize slowly in air. The pesticide is applied without dissociation of the liquid or as solid into dispersed particles. Some solid formulations of pesticide compounds are used as baits.

(3) *Additives.* Pesticide additives are materials that enhance the effectiveness of basic toxicant chemicals by altering their physical or chemical characteristics. Some additives, such as solvents and emulsifiers, are usually added to the basic active ingredient by the manufacturer at the time of production. Other additives, such as adhesives and diluents, may be added to the formulation by pest control personnel before application of the pesticide. Commonly used pesticide additives are:

(a) *Adhesive (sticker)—* a material used to cause pesticide adherence to a surface such as a plant leaf.

(b) *Attractunt-* a substance used to attract pests to pesticides or traps.

(c) *Diluent, Carrier—* a dry or liquid material added to a pesticide to facilitate formulation and/or distribution.

(d) *Emulsifier-* a material added to a pesticide formulation to produce an emulsion when the carrier solution is added. Some pesticide concentrates contain emulsifiers so that only the addition of water is needed.

(e) *Fluidizer-* a material used with a dust a formulation to prevent caking and permit the dust to flow easily during application.

(f) *Masking agent, Deodorant, Perfume-* a material used to remove or mask any unpleasant odor of a pesticide.

(g) *Solvent—a* material used to dissolve a pesticide for the preparation of a liquid formulation.

(h) *Spreader, Wetting Agent—a* material which reduces surface tension and, thereby, enhances spread of a solution or emulsion over a surface.

(i) *Synergist—* a material which, when added to a pesticide, increases the effectiveness of that pesticide. A pesticide with a synergist has a sum total effect greater than that of the pesticide or synergist alone.

(4) *Pesticide Dispersal.* After the desired formula-

tions have been determined and prepared or procured, they may be dispersed in the following forms:

(a) Gases *and Vapors.* The dispersal of gases and vapors is termed fumigation. They must be handled with great care and only under direct supervision of specially trained and certified personnel. Gases and vapors are able to penetrate packaged commodities, clothing and structures which are inaccessible to treatment by other dispersal methods. Because they lack residual properties, fumigants are used when other formulations are ineffective or because of penetration requirements. However, because of their physical properties, fumigants can be used only in airtight spaces which prevent dissipation. One type of fumigation, known as "vaporization," is accomplished by the use of solids such as paradichlorobenzene (PDB), which at room temperature, pass from a solid directly into a vapor. Fumigation procedures at military installations include the use of hydrogen phosphide gas (PH3) for food commodity treatment, methyl bromide for vacuum chambers for clothing and textiles at major supply depots, PDB for clothing protection and sulfuryl fluoride for structural pest control against such pests as drywood termites.

(b) *Aerosols.* Aerosols are defined as a suspension of liquid or solid particles in air where the particle size generally ranges from 0.1 to 50 microns in diameter with 80% of the particles in the 0.1 to 30 micron range. Liquid particles make up a fog and solid particles forma smoke. Insecticide aerosols are frequently dispensed from hand held pressurized containers or larger ultra low volume (ULV) dispersal equipment.

(c) *Mists.* Mists are dispersed particles in which the particles are intermediate in size between those of aerosols and fine sprays. Droplets in the 50 to 100 micron size range are considered to be mists. They are less effective than aerosols for outside space treatment, but they are adaptable for larviciding in areas accessible to vehicles and for large scale residual spraying of vegetation. Because of their larger size, mists can be used under a wider range of weather conditions than can aerosols, and their residual effect is greater. Mist formulations may be either oil solutions or water emulsions.

(d) *Sprays.* Sprays are the most commonly used formulation.

1. *Fine sprays.* Fine spray droplets are considered to be from 100 to 400 microns in diameter. Droplets within this range remain airborne short periods of time and settle rapidly. Sprays of this type are frequently used as mosquito larvicides and for residuals.

2. *Coarse sprays.* These sprays consist of droplets over 400 microns in diameter and are applied evenly to wet a surface. Coarse sprays are frequently employed when using herbicides and when applying heavy residuals of insecticide to fly breeding areas.

8-12. Application of Pesticides

(1) *Effects of Particle Size.* Efficient application of pesticides requires the dispersal of the proper particle size for the type of application desired. The residual quality of many insecticides makes it possible to kill by contact long after the material has been applied to walls, vegetation or other insect resting places. In order to take full advantage of the residual characteristics of a pesticide it should be applied only in the form of a coarse spray or dust. By contrast, efficient utilization of space sprays calls for their dispersal in much smaller particles. Coarse sprays are inefficient aerosols because the fewer number of droplets decreases the chances of target contact. Those particles which do contact the target may contain many times the *amount* of insecticide needed to effect a kill. Large particles fall to the ground while small particles may remain airborne for extended periods of time, providing more opportunity to contact targets. In this respect there is also a disadvantage in that unfavorable air currents or high wind velocity may cause rapid dispersal of the droplets into the atmosphere, and the small insecticide particles may be transported to non-target areas. Under favorable conditions aerosols or fogs are quite efficient for killing insects or other arthropods by means of space treatment.

(2) *Effect of Meteorological Conditions.* There are many conditions which may improve or reduce the effectiveness of the pest control program. In addition to a knowledge of the life history of the pest to be controlled, the proper choice of control technique, pesticide, and dispersal equipment, it must be remembered that meteorological conditions such as convection, relative humidity, wind velocity and direction, and temperature may add to the complexity of outdoor space spray operations.

(a) *Convection.* Once the pesticide is released from the nozzle, meteorological conditions are the only forces acting upon the particles. One of the most important of these is convection, or the upward and downward movement of a limited portion of the atmosphere. Convection influences the deposition of particles on the surface of the ground, foliage or target pest according to the existing temperature conditions. When the ground temperature is at least one degree cooler than surrounding air (inversion), aerosol droplets tend to drift near the ground within the zone where the target species is most likely to be contacted. Coverage of the area will generally depend on the wind conditions at the time. When the ground temperature is warmer than the air (lapse condition), small droplets in the mist and aerosol range tend to be carried up and out of the target zone by convection currents. Measurements of temperature to determine inversion or lapse conditions may be accomplished by using thermometers placed 0.3 and 1.8 m (1 and 6 ft) above the ground.

(b) *Wind.* Obviously, a fine spray or dust will be scattered over a very wide area during a high wind, especially under lapse temperature conditions. On the other hand, a lack of air movement will limit the pesticide distribution. Normally, it is an advantage to conduct outdoor space dispersal of aerosols if the movement of air is about 1 to 7 knots in a direction crosswind to the line of dispersal and toward the area to be treated.

(c) *Temperature.* Some pesticides may be more effective when air temperatures are 21 degrees C (70

degrees F) or above while others are more effective at lower temperatures. Pesticide labels can provide information regarding the influence of temperature on control.

(3) *Selection of method.* Before a vector control operation is undertaken one must determine if chemical control of the pest is the most satisfactory approach. Chemical control is the most expensive yet least permanent of the various methods of pest control. It should only supplement, not replace other vector control procedures. However, there are many situations where pesticides are valuable tools in the pest control program, such as during the threat of outbreak of vector-borne disease. Even during such times, control personnel should not lose sight of long range and more permanent measures.

(a) *Preventive Control.* Quarantine, drainage, impoundment, flushing, flooding, ditching, screening, sanitation, etc., are basic practices in the prevention of pest infestations. These methods of control are expensive initially but are the least costly and most effective over a long period of time. When military bases are of a permanent type, these methods are definitely preferred.

(b) *Chemical Control.* To employ chemical control measures is to admit the preventive measures are not adequate. This method of pest control is the most common and expensive, and it is temporary at best. In most field operations, when the site is to be occupied for short periods of time, chemical controls are used almost exclusively. Corrective controls are used until preventive controls are established and then only to augment more desirable methods of pest control. However, under combat conditions, chemical control may be the method of choice because of the need to rapidly reduce the vector population and because permanent control measures may be impossible due to lack of security.

8-13. Resistance to Pesticides

(1) *Definition of Pesticide Resistance.* Resistance of pests to pesticides is defined as the ability of a given population to withstand a poison that was effectively lethal to earlier generations of the species.

(2) *Development of Resistance.* Most normal populations of animal species include individuals that vary in their susceptibility to pesticides. Consequently, candidate pesticides will kill some individuals of a species more readily than others. Individuals in a population that are less susceptible to a chemical are considered to be more resistant. Continued pesticide pressure upon a population will destroy the most susceptible individuals, permitting the more resistant individuals to survive and produce generations of increasingly resistant offspring. Thus, the species becomes increasingly difficult to control because of genetic factors transmissible to subsequent generations. Development of resistance in a pest population can be subtle or quite dramatic. Houseflies were found to develop resistance to dichloro-diphenyl trichloroethane (DDT) within a year after it was introduced into areas of Europe. For mosquito control, the use of the same insecticide as a larvacide as well an adulticide is thought to enhance the development of resistance. Resistance is not confined to insecticides, nor is it always rapid in development. Some Norway and roof rats and house mice have become resistant to anticoagulant rodenticides in Europe and the United States after 20 years. Pesticide resistance has been reported for more than 225 species of arthropods. All of the modem day insecticide groups which include organophosphates, organochlorines and carbamates have examples of the development of resistance. Even cross resistance between these groups occurs. For example, chlordane (organochlorine), may increase, propoxur (carbamate) resistance in the German cockroach, *Blatella germanica.* This condition further complicates the situation for control work and necessitates reliance on specialists for recommending changes in methods, materials, and dosage rates. Not all field reports of resistance are valid. Other factors may be responsible for unsatisfactory control. Faulty techniques, chemical agents and equipment, inexperienced or incompetent operators, increased breeding rates, migration from outside the controlled area, and poor sanitation are a few of the more frequently observed reasons for ineffective control. It must be continually emphasized that change to another insecticide should be considered only when conclusive laboratory proof of resistance is obtained. The question of whether a resistant strain will revert to susceptibility when not exposed to the pesticide for a period of time has not been completely answered. The consensus among researchers is that while reversion will probably occur if there is no further exposure to the same or related pesticides, the time required will be dependent upon the degree of resistance developed. However, it has been experimentally demonstrated that once a resistant insect species has reverted back to susceptibility that resistance may quickly reappear with resumed use of the original insecticide.

Section III. PESTICIDE HAZARDS AND USE RESTRICTIONS

8-14. General

The information and directions on the pesticide label are important to every user. When properly followed, the directions provide maximal protection for applicators, consumers, and nontarget organisms. The label directions discuss the chemical hazards, registered uses, recommended doses, compatibility, phytotoxicity and legal restrictions. Read all pesticide labels prior to use. Do not rely on memory. With reasonable precautions most pesticides can be handled and used without undue hazard to health and the environment.

8-15. Assessment of Pesticide Hazards

(1) When selecting a pesticide for a control program, consideration must include the possible hazards to life other than the pests to be controlled since pesticides may be toxic to other living organisms. Considerable information has been disseminated concerning the safety/danger of pesticide products. Because of exaggerations regarding the dangers of DDT, its use has been prohibited except for public health emergencies, whereas the reported "safety" of pyrethrum has given rise to the feeling that pyrethroid formulations may be used with little or no precautions. All pesticides should be considered potentially harmful to humans to some degree; therefore, basic precautions must be practiced. No matter what material is used, it is standard procedure to protect food, cooking utensils, food preparation surfaces and to avoid continued human exposure to pesticidal fogs, sprays or dusts.

(2) When assessing the hazards of any particular pesticide, each of the following factors must be carefully considered and evaluated:

(a) Oral and inhalation toxicity
(b) Effect on the skin
(c) Accumulative effect on body organs
(d) Effect of prolonged exposure to small dosages
(e) Composition of the formulated pesticide
(f) Concentration of toxicants used
(g) Rate of deposit required for control
(h) Frequency of pesticide application
(i) Degree of exposure to pesticide residues
(j) Physical and chemical properties of the agent

(3) Constant awareness of hazards associated with pesticide handling and use, and careful attention to safeguards make it possible to use all standard military pesticides with a minimum of risk.

8-16. Toxicity of Pesticides

(1) Pesticides are toxic to humans and domesticated and wild animals in varying degrees and must be used with care. Toxicity varies with the chemical nature of each pesticide and may be rated subjectively as having low, moderate, high or extreme toxicities. Even though a pesticide may have a low toxicity rating, it may still be injurious, or even fatal, depending on the formulation, concentration at exposure, duration of exposure, and the body weight and general health of the person exposed. Data on chronic effects of pesticides on man are limited. The dose exposure required to produce acute poisoning is not applicable for predicting dosages producing subacute and chronic effects.

(2) *Toxicity Ratings.* A wide range of toxicity values for many of the pesticides have been reported. The values are expressed as acute oral or dermal lethal dose = 50% (LD50) in terms of milligrams (mg) of active ingredient ingested or contacted per kilogram (kg) of body weight of the susceptible animal. Respiratory doses are expressed in lethal concentrations (LC50) that will kill 50% of the exposed animals. No designed tests have been conducted in which humans have been subjected to lethal doses of pesticides. However, the effects of some chemicals on humans have been obtained from reports of accidental exposure or suicides. Information from these reports is frequently incomplete; consequently, evaluation of this type of data for estimating human toxicity of pesticides must be done with caution.

(3) The data on acute oral toxicity divide insecticides into four groups (Table 8-l). These groupings have considerable practical value because packaging labels must include key signal words (e.g. DANGER, POISON, WARNING, and CAUTION), and if applicable, antidotes and other necessary precautions.

8-17. Insecticide Hazards and Use Restrictions

(1) *General.* Insecticides, formulated as solids or wettable powders and dusts, pose less of a hazard by dermal poisoning than when in solutions. However, dusts and powders are easily inhaled and consequently produce a greater respiratory hazard. A notable exception is dieldrin which is extremely hazardous to man and animals when the skin is contaminated by dust *or* sprays.

(2) Stomach Poisons. Most of the substances used in stomach poisons to control insects are also toxic to man and animals. Although some are more toxic than others,

TABLE 8-1.

Criteria for Cataloging Pesticides by Toxicity, and Label Requirements Established by the Amended Federal Insecticide, Fungicide and Rodenticide Act of 1972

Signal Word & Antidote Statement	Toxicity & Acute Oral LD50 Value	Approximate Amount Needed to Kill the Average Person
I. "DANGER' "POISON Skull and Crossbones Antidote Statement "Call physician immediately"	Highly Toxic 0–50 mg/kg	a taste to a teaspoonful
II. "WARNING No antidote statement	Moderately Toxic 50–500 mg/kg	a teaspoonful to a tablespoonful
III. "CAUTION No antidote statement	Slightly Toxic 500–5000 mg/kg	an ounce to more than a pint
IV. No Warning, Caution or Antidote Statement Unqualified claims of Safety are not Acceptable	Comparatively free 5000 + mg/kg	more than a pint

Note: all pesticide products bear the words "Keep out of reach of Children"

each must be handled with care and used only in the amounts recommended for the specific pest.

(a) *Hazards.* All of the inorganic substances, including arsenic, lead, mercury and copper, are highly toxic to warm blooded animals. Great care must be exercised in handling, mixing and using all stomach poisons to prevent inhalation or accidental ingestation. Dermal contamination with arsenical compounds frequently results in inflammation and ulceration; thus, precautions should be taken to avoid spills and accidental dermal contact.

(b) *General Use Restrictions.*Stomach poisons are not to be used in any manner which is inconsistent with the directions on the label. These materials are not to be used in bodies of water due to toxicity to aquatic life, on food contact surfaces, or on plants used for food or forage. The drift of spray droplets must be avoided to eliminate contamination of nontarget areas. Contact with treated surfaces is not to be allowed until the spray has completely dried.

(3) *Contact Poisons.* Substances used for initial or residual contact pest control (diazinon, propoxur or chlordane) are all relatively toxic to man and animals. The degree of toxicity is related to the chemical and also to the type of formulation.

(a) *Hazards.* Many pesticides within this group are manufactured and marketed as a concentrate. Care must be exercised in handling, mixing and using all contact poisons to avoid accidental contact with skin or eyes, inhalation or ingestion.

(b) Use *Restrictions of Contact Poisons*

1. *Indoors.* Residual pesticides within this group that have EPA registration for use in food preparation areas are limited to crack and crevice treatment. Do not use these materials in occupied spaces and do not permit entry to an area prior to proper ventilation. Small amounts of these chemicals are applied directly into natural and construction cracks and crevices, between equipment bases and floors, into wall voids, motor housings, junction or switch boxes, conduits or hollow equipment legs, and any other place where pests may hide. In nonfood areas these pesticides may be applied by spray or brush to floors, walls, ceilings or other infested areas. Overall treatment of interior surfaces of occupied spaces is prohibited. No person or pets should be allowed to contact treated surfaces until the liquid residual dries.

2. *Outdoors.* Do not allow contact poisons to enter any body of water directly or as runoff because of their toxicity to aquatic life. Do not use these chemicals on food or forage plants or on animals in a manner other than that recommended on the label. Avoid drift of the sprays or dusts and keep domestic animals from contact with wet treated surfaces. Restrict application of these pesticides to infested areas.

8-18. Rodenticide Hazards and Use Restrictions

(1) *General.* If bait stations are accessible to children, pets or domestic animals, they must be kept in tamper proof boxes. Baits should be picked up and disposed of upon completion of the control program. Foodstuffs such as candy and cookies must not be used as baits to avoid attracting children's attention. Bait stations should be checked monthly, unless rodent activity is noted; then they should be checked at least weekly.

(2) Anticoagulant Baits. All normal pesticide precautions apply when handling single or multiple dose anticoagulant materials.

(3) *Fumigant.* The use of a fumigant (e.g. hydrogen phosphide or calcium cyanide) as a rodenticide may be hazardous to domestic and wild animals. These chemicals are not to be used without specific approval and guidance of a medical entomologist or applied biologist.

(4) *Other Rodenticides.* Sodium monofluoroacetate (1080) is extremely toxic and its use requires prior approval by the Surgeon General of the Navy. This chemical is odorless, tasteless, colorless and has an experimental LD50 of 0.22 mg/Kg.

8-19. Fumigant Hazards and Use Restrictions

(1) *Relatively Nontoxic Fumigants.* Chemicals such as PDB and naphthalene are relatively safe to use. However, prolonged inhalation of the vapors is harmful. They should not be used near open flames.

(2) *Extremely Toxic Fumigants.* Fumigants such as methyl bromide, aluminum phosphide (hydrogen phosphide), sulfuryl fluoride and hydrogen cyanide are to be used only by trained and certified personnel. These agents are not to be used without proper review and approval of a medical entomologist or applied biologist.

(2) Anticoagulant Baits. All normal pesticide precautions apply when handling single or multiple dose anticoagulant materials.

(3) *Fumigant.* The use of a fumigant (e.g. hydrogen phosphide or calcium cyanide) as a rodenticide may be hazardous to domestic and wild animals. These chemicals are not to be used without specific approval and guidance of a medical entomologist or applied biologist.

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Section IV. PRECAUTIONS IN HANDLING PESTICIDES

8-20. General

The precautions listed in this section will enable individuals to use, store, mix and dispose of pesticides and rinse solutions in a manner safe to themselves, other personnel and the environment. The user of pesticides is charged with the responsibility of knowing and complying with current EPA regulations and Navy standards. The NAVOSH Inspection Guide for Pest Control Operations Ashore published by NEHC, Norfolk, VA in 1985, is an excellent reference on this topic.

8-21. Personal Protective Equipment

(1) Personal protective equipment and clothing must be worn to protect all parts of the body from pesticide contamination and must be stored in an area separate from any pesticide exposure. Always read the pesticide label for recommendations on the use of protective clothing and devices.

(2) *Respiratory Protective Devices*

(a) Wearing a National Institute of Occupational Safety and Health NIOSH approved respiratory device is necessary any time inhalation of pesticides can occur. Wearing a respirator does NOT replace the need for protective clothing on other parts of the body.

(b) Specific types of cartridges and canisters protect against specific gases and vapors. For low concentrations of insecticide sprays, dusts, mists and vapors use an approved respirator with cartridge.

(c) Check the respirator's flutter valve to assure proper functioning.

(d) Respirator cartridges should be changed after 8 hours of use or sooner if pesticide odor is detected. During heavy spraying, change the respirator filters every 4 hours. After use, remove the filters and cartridges, wash the face piece with soap and water, rinse and dry it with a clean cloth and store it in a clean, dry place, preferably in a tightly closed paper or plastic bag away from pesticides and pesticide equipment.

(e) Specially designed gas masks should be worn when working with toxic pesticides in close or poorly ventilated spaces. Fumigation requires special consideration. Contact the fumigant manufacturer or area entomologists for specific instructions.

(3) *Eye Protection.* Wear either unvented or indirect vented goggles or a face shield to prevent contamination of the eyes with pesticides. After use, wash the goggles with soap and water, rinse and dry with clean cloth and store with the respirator.

(4) *Body Protection.* A long sleeve shirt and full length trousers or coverall type garment (all of closely woven fabric) should be worn any time that pesticides are handled.

(a) A lightweight raincoat or rubber apron should be worn when handling pesticide concentrates or very toxic materials.

(b) Trousers should be worn outside of lightweight rubber boots to prevent pesticides from getting inside the boots.

(c) A clean set of clothing should be worn daily. If fabrics get wet during operation, change immediately. Wash contaminated clothing separate from other clothing. Do not take protective clothing home to be laundered. Laundering facilities should be provided.

(5) *Head Protection.* Always wear something to protect the head. Pest control operators usually wear hard hats. When there is a possibility of drift, wear a wide-brimmed, waterproof hat to protect neck, eyes, mouth and face.

(6) *Hand Protection.* When handling concentrated or highly toxic pesticide, wear liquid-proof, solvent resistant gloves (e.g., rubber or neoprene). They should be long enough to protect the wrist. Gloves should not be

fabric lined since this is hard to clean if contaminated. Never use gloves of an absorbent material because they do not provide adequate protection. Garment sleeves should be positioned outside of the gloves to keep pesticides from running into the gloves. Wash gloves daily and test for leaks by filling them with water and gently squeezing.

(7) *Ear Protection.* Ear protection is important during use of large pesticide dispersal equipment. Ear muffs provide maximum sound protection. It is extremely important that ear protective devices, whether plugs or muffs, be cleaned after use.

8-22. Pesticide Formulation, Storage, Fire Protection and Transportation

(1) Formulation of pesticides must be done in areas separate from office and locker spaces. Formulation areas should be equipped with a ventilation hood, adequate lighting, and washing and shower facilities.

(a) The pesticide handling area must be able to contain spilled pesticides and rinse solutions to prevent environmental contamination.

(b) Put on the correct protective equipment and clothing before handling any pesticide container.

(c) Carefully read the entire label each time before removing the pesticide from the container. This precaution is necessary since formulation directions are frequently changed.

(d) Always formulate in the specially designed area and keep the pesticide container below eye level to avoid a splash or spill on goggles. Use a sharp tool to open paper containers. Do not tear them open.

(e) Use only the amount specified on the label.

(f) Post written safety procedures to be followed in the case of pesticide spills. These procedures should include the medical department's telephone number and the location of decontamination materials.

(g) If the user becomes contaminated with pesticide, stop immediately and remove the contaminated clothing. Wash the exposed area thoroughly with soap and water. Speed is important because of the rapid absorption rate of pesticides by the body (15 minutes or less).

(h) After use, replace all pour caps and reseal bags and other containers to prevent spills and cross contamination n.

(2) Read the label containers of each pesticide for correct storage procedure. Fumigants require additional storage safety precautions.

(a) In addition to posted procedures for handling pesticide spills, maintain a current listing of all pesticides in storage and keep it readily available for emergency use. This list should also be maintained as an appendix to the activity pest management plan with a copy filed with the activity's medical and fire departments. The list should include the following information:

1. Manufacturer or distributor
2. Chemical name or group (e.g., organophosphate)
3. Concentration
4. Type of formulation (e.g., oil solution, duet)
5. Toxicity
6. Quantity
7. Flashpoint
8. Type of container (e.g., glass, drum)
9. Common, or brand name of pesticide
10. EPA registration number

(b) Storage areas should have washing and fire fighting capabilities and provisions to contain spills and decontaminate the area.

(c) The medical department should be informed of the potential for pesticide poisoning so that proper antidotes are available. The medical department, and/or emergency room of the medical treatment facility should have a copy of the emergency pesticide poisoning wall chart prominently displayed and should maintain antidotes for highly toxic pesticides,

(d) Security personnel should also be informed of the hazards in pesticide storage areas.

(e) As soon as pesticides are delivered, mark the date of receipt on the container. Store in a locked and posted facility away from unauthorized individuals. Keep storage entrances locked when trained personnel are not present.

(f) Storage areas must allow the pesticides to be kept dry, cool, and out of direct sunlight to avoid deterioration. They should be insulated to prevent the chemicals from freezing or exposure to temperatures in excess of 100 degrees F.

(g) Storage areas should be of fire resistant construction with a concrete floor and good lighting. Provide an exhaust air ventilation system which provides at least six fresh air changes per hour. This ventilation system need only operate when the storage and formulation areas are occupied. The light and exhaust switch with a pilot light shall be located outside the door and marked with a sign reading "OPERATE VENTILATION SYSTEM DURING OCCUPANCY".

(h) Storage areas should be liquid tight with a raised sill or a floor at least 10.2 cm (4 in) below the surrounding floor. Openings must have approved self-closing fire doors.

1. A clear aisle of at least 0.9 m (3 ft) shall be maintained.

2. Containers of flammable or combustible material over 1141 (30 gal) in size shall not be stacked upon each other. Dispensing shall be by pump or self-closing faucet devices bearing manufacturer's laboratory tested approval.

3. Storage areas shall have safe, clearly marked exits that are unobstructed at all times.

(i) Do not store fertilizers and pesticides in the same building because of a difference in applicable fire control methods.

(j) Store all pesticides in the original containers where the label is plainly visible. Never put pesticides in another container unless the original has deteriorated. If repackaging is necessary, ensure identical labeling of the new container. Dispose of deteriorated containers properly (Article 8—24).

(k) Never store herbicides with other classes of pesticides. Pesticides contaminated by volatile herbicides can cause unintentional damage to lawns and plants. Also, periodically check all pesticide containers for leaks or breaks and clean up any spilled material and repackage the contents from damaged containers.

(4) Fire protection in the shop area generally can be accomplished with portable fire extinguishers. Contact the fire department for assistance.

(a) Smoking is NEVER permitted in a pesticide handling area. Appropriate warning signs should be posted and enforced.

(b) It is important to inventory the amounts and types of flammable and combustible liquids in each area. Combustible liquids are those with flash points greater than 37.8 degrees C (100 degrees F) and flammable liquids are those with flash points below 37.8 degrees C (100 degrees F). These liquids must be stored in proper containers. Breakable containers must be protected by cases, boxes, or proper shelving.

(c) In pest control shops the potential for either class A, B, or C fire exists. Therefore, it is recommended that pesticide storage and formulation areas have multirated fire extinguishers.

(d) The number of fire extinguishers needed to protect a shop is based on several factors. Usually at least one in the storage/mixing area and one in the general shop area is sufficient. The maximum allowable distance permitted for travel to an accessible fire extinguisher for flammable liquids is approximately 15 meters (50 ft).

(e) Fire extinguishers shall be conspicuously marked and located where they will be readily observed and immediately available for use.

(f) Special fire hazards created by pesticides include toxic fumes from volatized chemicals, accidental contamination of firemen, potential explosion of combustible pesticides and/or their solvents and environmental contamination from runoff water if used for fire control.

(5) *Transportation of Pesticides*

(a) The user of pesticides is legally responsible for their safe transportation after purchase and possession.

(b) Carry pesticides in the back of a truck, never in the cab. They should be securely fastened, enclosed and locked to prevent spillage and contamination of personnel and equipment. Vans should be prohibited from use as pest control operator vehicles.

(c) Special precautions should be allowed for paper containers to protect them from moisture damage.

(d) Signs should be secured properly on the vehicle to warn of the potential hazard.

(e) If any pesticide is spilled in or from the vehicle, clean up the spillage as discussed in Article 8—23.

(f) Pest control vehicles must carry a small spill clean-up kit and a container of eye wash solution.

8-33. Decontamination of Equipment and Pesticide Spills

(1) Decontamination is removal of the toxicant to a disposal area. It is NOT NEUTRALIZATION.

(2) The amount of cleaning solution used for decontamination should be kept to a minimum because it must be disposed of in the same manner as waste pesticides.

(3) The first step in decontamination of an area or piece of equipment from a minor spill is to confine the pesticide. If the chemical starts to spread, contain it with dikes of sand or dirt. For dry pesticide spills, clean up the agent and treat the contaminated surface as directed in Article 8—23 (6) and (7) below.

(4) Use an absorbent material, such as fine sawdust or other specially designed material, to soak up the spilled liquid pesticide.

(5) Shovel all of this contaminated material into a leak-proof barrel for disposal.

(6) Do not flush the contaminated area. Treat contaminated surfaces with detergent and water or chlorine bleach. The latter solution may be used on all groups of pesticides except organochlorines. With a long handled broom and decontamination solution, thoroughly scrub the exposed surface.

(7) Soak up the decontamination solution with absorbent material and place it in a barrel for disposal.

(8) Repeat the washing and collection procedure of steps (6) and (7) above until all of the pesticide is removed.

(9) For major spills follow the same procedure, then call the medical or area entomologist or Pesticide Safety Team Network (phone no. (513) 961-4300) collect for specific instructions and assistance.

(10) If a major spill occurs on a highway, have someone notify the highway patrol or local sheriff. Do not leave the area until responsible assistance arrives and has been apprised of the dangers involved.

(11) All movable equipment used for handling pesticides and pesticide containers should be designated as pest control equipment and should not be removed from the working areas unless thoroughly decontaminated.

(a) Appropriate protective clothing should be worn during the machine cleaning process.

(b) Clean equipment with detergent and water solution or spray lime [1.4 kg (3 lbs) in 18.91 (5 gal) of water]. Dispose of cleaning and rinse solution in a sanitary sewer system according the EPA regulations where legal.

8-24. Pesticide and Container Disposal

(1) Pesticides should be disposed of only if the products are contaminated, outdated, no longer needed, or cannot be used at another activity.

(2) Contact your regional Defense Reutilization and Marketing Office of the Defense Logistics Agency for specific details on pesticide disposal.

Section V. FIRST AID AND EMERGENCY TREATMENT FOR PESTICIDE EXPOSURE

8-25. General Procedures

(1) Strict adherence to basic principles in rendering first aid to victims of pesticide contamination and poisoning may avert disfigurement, health compromise and possibly loss of life. A chart, *Emergency Medical Treatment for Acute Pesticide Poisoning,* available from any DVECC or NEPMU, should be posted in conspicuous places where pesticides are stored, issued, mixed or handled and in emergency rooms of medical treatment facilities.

(2) Decontamination is extremely important in pesticide poisoning and should be done as quickly as possible. When properly accomplished according to the nature of exposure, decontamination terminates exposure and, thereby, limits the dose.

(3) It is important that the pesticide container, a sample of the remaining residue and a readable label or the names of the chemical constituents be saved for use by the medical officer.

(4) Supportive therapy does not counteract the specific toxic action of the pesticide, but assists in maintaining vital body functions. The purpose of supportive therapy is to keep the patient alive until specific antidotes can be given and take effect or until the body has sufficient time to metabolize and detoxify the poison. Supportive therapy includes the following

(a) Cardio-pulmonary resuscitation

(b) Artificial respiration (mouth to mouth if oral intake of the pesticide is not involved)

(c) Maintenance of a free airway

(d) Oxygen therapy for cyanosis

(e) Postural drainage

(5) A nation-wide network of Poison Control Centers (PCC) has been established in conjunction with the Public Health Service (PHS). These Centers are usually located in local hospitals and are geographically located to be available by telephone from almost every part of the country. Their staff members are specially trained for the treatment of poison cases. When requiring information and assistance, dial the number given for the PCC in the nearest city. Also, ask the operator for the name of the person who is in charge. This will eliminate unnecessary delay and possible misunderstanding.

8-26. First Aid for Pesticide Contamination

(1) *Eye contamination*

(a) Holding the lids apart, wash the eye for 5 minutes with a gentle stream of running water.

(b) Do not use chemical antidotes because they may increase the extent of injury.

(2) *Skin contamination*

(a) Flood the skin with water

(b) Direct a stream of water onto the contaminated area whale removing the patient's clothing.

(c) Do not use chemical antidotes.

8-27. First Aid for Internal Poisoning from Pesticides

In the event of internal pesticidal poisoning, render first aid as follows:

(1) When possible obtain immediate, on-the-spot services of a physician. If this is not possible, administer the antidote recommended on the label of the pesticide container, then rush the victim to the nearest medical facility. Never attempt to administer an oral antidote to an unconscious victim.

(2) In the event no specific antidote is recommended on the label of the pesticide container, administer the treatment as recommended on the "Emergency Medical Treatment for Acute Pesticide Poisoning Chart" until the services of a physician are available.

(3) If the victim is cold cover him with a light blanket. To avoid burns, hot objects should not be used to warm the patient.

(4) In the event the victim stops breathing or breathing becomes difficult, administer the appropriate artificial respiration.

8-28. First Aid for Poisoning by Fumigants

In the event of poisoning by toxic gases, render first aid as follows:

(1) Quickly move the victim to a source of fresh air (outdoors if possible).

(2) Call a physician promptly, or rush the victim to the nearest medical facility.

(3) Remove contaminated clothing, but keep the patient warm.

(4) If the prompt services of a physician are not available, administer the antidote recommended on the label of the fumigant container.

(5) In the event that the victim stops breathing or if breathing becomes difficult, administer mouth-to-mouth artificial respiration.

8-29. Organophosphorus Pesticide Poisoning and Suggestions for Treatment

(1) *Organophosphorus pesticides cause irreversible cholinesterase inhibition.* Examples include: chlorpyrifos, diazinon, dichlorvos, malathion, and naled.

(2) Signs *and Symptoms*

(a) *Mild:* Headache, dizziness, weakness, anxiety, pupillary contraction, blurred vision and nausea.

(b) *Moderate:* Nausea, salivation, lacrimation, abdominal cramps, diarrhea, vomiting, sweating, slow pulse, muscular tremors and respiratory compromise.

(c) *Severe:* Respiratory difficulty, pinpoint and non-reactive pupils, pulmonary edema, cyanosis, loss of sphincter control, muscle spasms, convulsion, coma and eventual death due to respiratory failure.

(3) *Antidote*

(a) *Adults.* After cyanosis is overcome, give 2 to 4 mg of atropine sulfate intravenously (IV). Repeat doses at 5 to 10 minute intervals until signs of atropinization appear. Maintain treatment for 24 hours or longer if necessary. A total of 25 to 50 mg or more may be necessary during the first day.

(b) *Children.* Give atropine sulfate in proportion to body weight—approximately 0.05 mg/kg.

(c) *Support therapy.* 2-PAM (Pralidoxime Chloride or Protopam Chloride).

1. Adult dose-1 gm IV slowly.
2. Infant dose-250 mg IV slowly.

NOTE: Contraindicated treatment compounds include: aminophylline, barbiturates, morphine, phenothiazine tranquilizers, theophylline, or any respiratory depressant.

8-30. Carbamate Pesticide Poisoning and Suggestions for Treatment

(1) *Commonly used pesticides which exhibit reversible cholinesterase inhibition* include carbaryl, dimetilan and propoxur.

(2) Signs *and symptoms of poisoning* include pupillary constriction, salivation, profuse sweating, lassitude, muscle incoordination, nausea, vomiting, diarrhea, epigastric pain and tightness in chest.

(3) *Antidote*

(a) *Adults.* After cyanosis is overcome, give 2 to 4 mg of atropine sulfate IV. Repeat doses at 5 to 10 minute intervals until signs of atropinization appear. Maintain treatment for 24 hours or longer if necessary.

(b) *Children.* Give atropine sulfate in proportion to body weight—approximately 0.05 mg/kg IV.

NOTE: 2-PAM is contraindicated in carbamate insecticide poisoning. Also avoid aminophylline, barbiturates, morphine, phenothiazine, tranquilizers and theophylline.

8-31. Organochlorine Pesticide Poisoning and Suggestions for Treatment

(1) *Organochlorine pesticides are central nervous system depressant/stimulants.* They include benzene hexachloride (BHC), chlordane, DDT, dieldrin, heptachlor and lindane. The exact mode of actions of these chemicals is not known. In general they act on the central nervous system to stimulate or depress, varying by compound. Repeated doses may affect liver and kidney functions.

(2) Signs *and symptoms.* Within 20 minutes to 4 hours, the following may occur headache, nausea, vomiting, restlessness, tremor, apprehension, convulsions, coma, respiratory failure and death. Do not induce vomiting if the ingested poison is principally an organic solvent (e.g., kerosene).

(3) *Treatment*

(a) Lavage stomach with 2–4 liters of tap water. Induce catharsis with 30 gm sodium sulphate in one cup of water.

(b) Administer barbiturates in appropriate doses repeated as necessary for restlessness or convulsions.

(c) Avoid oils, oil laxatives and epinephrine (adrenalin). Do not give stimulants.

(d) Give calcium gluconate (10% in 10 ml ampules) IV every 4 hours.

8-29. Organophosphorus Pesticide Poisoning and Suggestions for Treatment

(1) *Organophosphorus pesticides cause irreversible cholinesterase inhibition.* Examples include: chlorpyrifos, diazinon, dichlorvos, malathion, and naled.

(2) Signs *and Symptoms*

(a) *Mild:* Headache, dizziness, weakness, anxiety, pupillary contraction, blurred vision and nausea.

(b) *Moderate:* Nausea, salivation, lacrimation, abdominal cramps, diarrhea, vomiting, sweating, slow pulse, muscular tremors and respiratory compromise.

(c) *Severe:* Respiratory difficulty, pinpoint and non-reactive pupils, pulmonary edema, cyanosis, loss of sphincter control, muscle spasms, convulsion, coma and eventual death due to respiratory failure.

(3) *Antidote*

(a) *Adults.* After cyanosis is overcome, give 2 to 4 mg of atropine sulfate intravenously (IV). Repeat doses at 5 to 10 minute intervals until signs of atropinization appear. Maintain treatment for 24 hours or longer if necessary. A total of 25 to 50 mg or more may be necessary during the first day.

(b) *Children.* Give atropine sulfate in proportion to body weight—approximately 0.05 mg/kg.

(c) *Support therapy.* 2-PAM (Pralidoxime Chloride or Protopam Chloride).

1. Adult dose-1 gm IV slowly.
2. Infant dose-250 mg IV slowly.

NOTE: Contraindicated treatment compounds include: aminophylline, barbiturates, morphine, phenothiazine tranquilizers, theophylline, or any respiratory depressant.

8-30. Carbamate Pesticide Poisoning and Suggestions for Treatment

(1) *Commonly used pesticides which exhibit reversible cholinesterase inhibition* include carbaryl, dimetilan and propoxur.

(2) Signs *and symptoms of poisoning* include pupillary constriction, salivation, profuse sweating, lassitude, muscle incoordination, nausea, vomiting, diarrhea, epigastric pain and tightness in chest.

(3) *Antidote*

(a) *Adults.* After cyanosis is overcome, give 2 to 4 mg of atropine sulfate IV. Repeat doses at 5 to 10 minute intervals until signs of atropinization appear. Maintain treatment for 24 hours or longer if necessary.

(b) *Children.* Give atropine sulfate in proportion to body weight—approximately 0.05 mg/kg IV.

NOTE: 2-PAM is contraindicated in carbamate insecticide poisoning. Also avoid aminophylline, barbiturates, morphine, phenothiazine, tranquilizers and theophylline.

8-31. Organochlorine Pesticide Poisoning and Suggestions for Treatment

(1) *Organochlorine pesticides are central nervous system depressant/stimulants.* They include benzene hexachloride (BHC), chlordane, DDT, dieldrin, heptachlor and lindane. The exact mode of actions of these chemicals is not known. In general they act on the central nervous system to stimulate or depress, varying by compound. Repeated doses may affect liver and kidney functions.

(2) Signs *and symptoms.* Within 20 minutes to 4 hours, the following may occur headache, nausea, vomiting, restlessness, tremor, apprehension, convulsions, coma, respiratory failure and death. Do not induce vomiting if the ingested poison is principally an organic solvent (e.g., kerosene).

(3) *Treatment*

(a) Lavage stomach with 2–4 liters of tap water. Induce catharsis with 30 gm sodium sulphate in one cup of water.

(b) Administer barbiturates in appropriate doses repeated as necessary for restlessness or convulsions.

(c) Avoid oils, oil laxatives and epinephrine (adrenalin). Do not give stimulants.

(d) Give calcium gluconate (10% in 10 ml ampules) IV every 4 hours.

Section VI. VECTOR CONTROL: SHIPBOARD AND ASHORE

8-32. Shore Installations

Pest Management Programs at shore installations are covered in DOD Directive 4150.7, OPNAVINST 6250.4 and NAVFACINST 6250.3G. The DVECC publication, *Pocket Guide to Pest Management* (current edition), and The Armed Forces Pest Management Board publication, *Contingency Pest Management Pocket Guide,* also contain valuable information on the procurement and use of pesticides and pest control equipment. The above listed publications and references should be used in conjunction with control recommendations contained in this chapter.

8-33. Advanced Bases and Disaster Areas

Vector control components and disaster vector control survey teams serve as "Special Operating Units" and carry out the responsibilities described in Article 8—3 under the direction of the supervising medical department.

8-34. Flies

(1) *Relation to man.* The importance of many fly species to man is their capability of transmitting human and zoonotic diseases which may seriously hamper military operations. In addition to the health aspect, virtually all fly species can be annoying pests of man. One of the most important of these pests is the house fly. While being a serious annoyance, it is capable of transmitting disease-producing organisms via its vomitus and excrement, and on its contaminated feet, body hairs and mouthparts. Chief among these organisms are those which cause cholera, dysentery, and typhoid fever. Blow flies carry many of the same organisms. Their larvae sometimes develop in wounds or natural body openings causing a condition known as myiasis. The stable fly, unlike the above two insects, is a blood-sucking fly and is suspected of transmitting anthrax and tularemia. Sand flies transmit tropical and subtropical diseases. Punkies, or biting midges, are minute blood-sucking flies which cause extreme annoyance to man in many parts of the world. Tsetse flies are blood-sucking and of considerable importance because they transmit the protozoan trypanosomes which cause human African sleeping sickness. Black flies are small blood-sucking insects which are important as pests in areas of running streams, but even more so, as the vectors of filarial parasites in Mexico, Central America, and Africa. Horse and deer flies are blood-sucking insect pests which attack both man and animals. They also transmit tularemia. Eye gnats are nonbiting flies which are attracted to wounds, pus, and secretions around the eyes and nose. In some parts of the United States they mechanically transmit the organism which causes acute infectious conjunctivitis (pink eye).

(2) *Biological characteristics.* All flies resemble each other in having two wings and four major developmental stages (egg, larva, pupa and adult). A summarized description of the biology of each of the principle types follows:

(a) *House fly (Musca domestics).* This fly is ubiquitous and consequently is possibly the most widely distributed insect of importance to mankind. Its eggs are deposited in decaying vegetable and animal matter such as garbage, contents of pit latrines, animal manure, spilled animal food and soil contaminated with organic matter. The female may lay as many as 20 batches of eggs at 3 to 4 day intervals. Under favorable conditions the eggs hatch in 8 to 12 hours. The larvae (maggots), which are creamy white and grow to about 13 mm (0.5 in) in length, move about in the breeding medium to secure optimum temperature and moisture conditions. This developmental stage varies from 3 to 24 days but usually, in warm weather, it is 4 to 7 days. When growth in this stage is completed, the larvae crawl to the edge of the breeding medium, burrow into the soil or debris, and become encased in a brown pupal case. The pupal stage usually lasts 4 to 5 days but, under very warm conditions, only 3 days maybe required. In cold weather this stage may last for several weeks. When metamorphosis , (from the larval to adult stage) is complete, the adult fly breaks open the end of the puparium and crawls out. It works its way to the surface, expands its wings and flies away. Mating occurs 1 to 2 days after pupal emergence. The adult is gray in color with a gray thorax marked by four equally broad, dark longitudinal stripes. The mouthparts are nonbiting and adapted to sponging. House flies utilize a wide variety of material for food including organic filth, human food stuffs, and agricultural waste. Because they can take only liquified foods, they moisten substances with a "vomit drop" from the crop. This drop of fluid, often teeming with microorganisms, dissolves solid materials to be used as food. This fluid food is sponged up. This feeding method, combined with the habit of walking over organic filth, accounts for the ease with which they transmit disease organisms to food, and cooking and eating utensils. The "fly speck vomitus (light colored) and fecal discharge (dark colored) both serve as sources of contamination. When inactive, flies tend to congregate in certain preferred resting places. The proper use of residual sprays for house fly control requires that these resting places be determined. Indoors, flies tend to rest on overhead structures, particularly on cords and the edges of objects. Where temperatures remain high during the night, house flies frequently congregate outdoors on fences, weeds and in low branches of trees. Although house flies usually stay within a short distance of the breeding sites, they may become dispersed for distances of several miles. In tropical and subtropical areas, house flies continue breeding at varying rates throughout the winter. In temperate areas, depending on the weather, these flies survive the winter by pupal hibernation and semicontinuous breeding in protected situations.

(b) *Blow fly (Calliphora, Chrysomya, Lucilia, Phaenicia, Phormia, etc.).* Blowflies, also known as bluebottle and green-bottle fries, are identifiable by their large metallic shining blue, green, or black abdomens. They usually deposit their eggs upon carrion; however, they will oviposit upon a wide range of fresh decaying refuse if carrion is not available. Eggs occasionally may be deposited in or near body openings of living animals,

but clean healthy animals are rarely attacked. Upon emergence from the egg, the larvae feed for a short time on or near the surface. As the necrotic tissue food source is depleted, they move into areas of less putrid material. When fully developed, the larvae leave the breeding medium and burrow into loose soil or sand to pupate. The life cycle varies from about 9 to 25 days. Blow flies are keenly perceptive to odors given off by carrion and, consequently, will fly long distances in response to this stimulus. Although blow flies may serve as mechanical vectors of disease organisms in the same way as house flies, they do not present the same public health problem since they rarely enter dwellings. The larvae of these flies, sometimes referred to as surgical maggots, have been implicated in myiasis.

(c) *Flesh fly (Sarcophagi and Wohlfahrtia). The* flesh flies are medium gray in appearance and are often relatively large in size. They are distinguished from other domestic flies by the presence of three longitudinal black stripes on the thorax and a checkered effect on the usually red-tipped abdomen. These flies are commonly referred to as flesh flies since the larvae of some of them infect living flesh. Many species are known to breed prolifically in animal feces, especially that of dogs. They differ from other domestic flies in that the females deposit larvae rather than eggs. The flesh flies are often very abundant, but they do not ordinarily enter habitations. They do not appear to be of importance to man from the standpoint of mechanical disease transmission, nor are they considered an important pest. However, they are important as an indication of unsanitary conditions and have been associated with cutaneous, genitourinary, intestinal, and naso-pharyngeal-opthalmo myiasis.

(d) *Bot* and *warble flies (Cuterebra, Dermatobia, Gasterophilus, Hypoderma, and Oestrus). These* flies cause obligate myiasis. Normally the larvae of bot flies *(Gasterophilus spp.)* inhabit the gastro-intestinal canal of animals of the family Equidae. Larval development requires 10 to 11 months. In the rare cases of human infection, first stage larvae are found under the skin giving rise to a creeping cutaneous myiasis. Treatment is by surgical extraction. Among the warble flies, the larvae *of Dermdobia hontinis,* whose eggs maybe transmitted by mosquitoes, is found in the human skin in Central and tropical South America. The life cycle requires 3 to 4 months. Larvae of *Oestrus* spp. are found in the nasal cavities and cranial sinuses of sheep, goats, and related wild animals. In areas where numerous infested animals occur, man may become infested. In these cases, the larvae may be found in the buccal mucosa and conjunctival, but more frequently in the nasal cavities. Severe frontal headaches result. The larvae of *Hypoderma* spp. can be found under the skin of cattle, goats, deer, and large game animals. They can give rise to creeping eruption in man. Numerous human infections occur and the incidence is proportionally higher in children than adults. With man being an unnatural host, the larvae may migrate throughout the body (e.g., eyes, dermal and subdermal tissue, the jaw, and possibly the spinal canal). Associated pain is severe, and while death may result, surgical removal is possible. *Cuterbra* spp. larvae commonly cause myiasis in rodents of many genera and rabbits. In these animals, severe infestations may lead to encapsulating dermal tumors. Occasionally dogs, cats and man may become infected. Although rare, in human cases, the larva forms a boil-like lesion in the dermal and subdermal tissue, but the larvae are easily removed.

(e) *Stable fly (Stomoxys calcitrans). The* stable or dog fly is blood-sucking and closely resembles the house fly in appearance. It is distinguished from other domestic flies by its piercing proboscis which protrudes bayonet-like in front of the head. It normally breeds in wet straw, mixed straw and manure or piled fermenting vegetation, such as grass, seaweed, and similar materials. Development requires 21 to 25 days. The stable fly is not attracted to and does not breed in human food, feces, garbage, and other filth which are attractive to the house fly. Consequently, it is not considered to be an important mechanical transmitter of human disease organisms. However, its painful biting habits make it a serious pest for morale. There is some evidence to implicate this fly with the transmission of anthrax and tularemia. Rarely, it becomes involved in accidental traumatic and enteric human myiasis.

(f) *Horn fly (Haemutobia irritans).* The horn fly is a cattle pest related to *S. calcitrans.* The female prefers to oviposit in fresh cow feces. Upon hatching, the larvae crawl into the fecal mass, develop for 3 to 5 days, pupate under the pat and emerge as adults in about 7-days. The life cycle is completed in 10 to 14 days. The horn fly rarely bites man, but in large numbers it does cause annoyance.

(g) *Tsetse fly (Glossina* spp.). Tsetse flies are easily recognizable by the way in which they fold their wings scissor-like above the abdomen when resting, the characteristic distal cell (cleaver shaped) in the wing, and the prominent biting mouthparts. These flies are restricted to the African continent south of the Sahara Desert. The female periodically produces a single, fully developed larva which pupates almost immediately in loose soil, moss or other accumulations of material. Usually, tsetse flies require bush, thickets or forest to rest and breed. Open areas, savannah or openings in the forest are preferred for feeding. Both sexes of these flies are blood suckers that feed on man and animals and transmit the protozoan disease, trypanosomiasis.

(h) *Sand fly (Phlebotomus* spp.). The flies of this genus are small and moth-like, rarely exceeding 5 mm 1/25 in) in length. Their bodies and wings are densely covered with hairs. The wings are either oval or lanceolate shaped and, when at rest, are held upward and outward to form a 60 degree angle with each other and the body. Only the females have piercing mouthparts for sucking blood. The males suck moisture from any available source. They have a wide distribution, occuring in such diverse places as deserts and jungles, but are absent from the colder regions of the Temperate Zones. They invade open dwellings to bite man during the evening and night, hiding in dark protected places during the day. Indoors, they may be found in dark cor-

ners and near the ceilings of sleeping quarters. While outdoors, they hide in masonry cracks, stone walls, excavations, animal burrows, hollow trees and deep cracks in the soil. The eggs are laid where there is an abundance of organic matter and sufficient moisture for their development. They are weak flyers. Their mode of flight is characteristic in that for longer distances they have slow steady movement. For shorter distances they move in so-called "hops." Normally, their dispersal is limited to the immediate region of their breeding areas. The diseases these flies transmit to man are bacterial (bartonella), viral (sand fly or pappataci fever) and protozoal *(Leishmania* spp., kala-azar, oriental sore and American mucocutaneous leishmaniasis).

(i) *Black fly (Simulium* spp.). Black flies are small, 1 to 5 mm (1/25 to 1/5 in) in length, dark, stout-bodied, humpbacked flies with short broad wings in which only the anterior veins are well developed. The antennae are short and stubby. The immature stages of black flies develop in running water. Usually, masses of eggs are deposited singly directly on to aquatic plants., submerged logs and watersplashed rocks. However, some species drop their eggs while flying over the water surface and the eggs sink to the bottom. Following incubation, the eggs hatch and the larvae become attached by a caudal sucker to submerged objects. They are kept from being washed away by a salivary gland secreted silken thread. Larvae feed on microorganisms which are strained from the water after being swept into the mouth by a pair of fan-shaped filamentous structures on the head. They breathe by obtaining oxygen from the water through three small gills located dorsally on the last abdominal segment. The larvae pupate within the cocoon which it spins, firmly attached to a submerged object. Depending on the species and environmental factors such as temperature and availability of food, the total period of the aquatic life stages may vary from 2 to 14 weeks. Metamorphosis to the adult takes place within the cocoon. Upon emerging and rising to the surface, the fly takes wing immediately. Little precise information is available on the dispersal range of black flies, but it is believed to be more than a mile, particularly in open terrain. Like mosquitoes, both sexes of black flies feed on plant juices. The females also feed on the blood of wild and domestic animals and birds, while several species regularly feed on man. Only the females bite. Due to the large size of the bite wound and the presence of fly secreted anticoagulant, the bites bleed freely and may become secondarily infected. Several species cause serious annoyance to man because of the habit of flying closely about the face and crawling or probing all exposed skin surfaces. The females vector the filarial parasites which cause onchocerciasis in man and animals, and the protozoan blood parasite, *Leucocytozoon.*

(j) *Biting midges (Culicoides, Leptoconops, etc.).* These bloodsucking flies, often called no-see-urns, punkies, or salt-marsh sand flies, are extremely small [1 to 5 mm (1/25 to 1/5 in) in length] and have long slender antennae and narrow wings which are carried flat over the body. Although information on their breeding habits is not complete, some species are known to breed in fresh water inlets, tidewater pools, water-holding tree holes, wet decaying humus along densely shaded areas of streams, and in marshes and swamps. Adults may be found as far as 5 km (3 mi) from their breeding sites. The female inflicts a painful bite, attacking humans mainly in the evening and early morning hours. Heavy concentrations of these flies will hamper military operations by adversely affecting morale.

(k) *Horse and deer flies (Tabanus, Chrysops, etc.).* Horse and deer flies are robust insects, with powerful wings and large rounded heads. They range in size from about that of a house fly to nearly 25 mm (1 in) in length. They prefer warm, sunny locations, and are especially active on humid days. Eggs are glued in layers or masses to rocks or vegetation overhanging water or damp soil. The egg stage usually lasts less than 2 weeks. Upon hatching, the larvae drop into the water or to the ground. Depending upon the species, the larvae require 1 to several years to complete development. Mature larvae migrate to dryer soil for pupation where after 1 to 2 weeks the adult flies emerge. These flies inflict exceedingly painful bites and, when numerous, seriously interfere with outdoor operations or recreation. They are also known to vector bacterial (anthrax and tularemia), protozoan (trypanosomes) and helminthic *(Loa loa)* infections to man and/or animals.

(1) *Eye gnat (Hippelates).* Members of the genus *Hippelates* are very small flies (1.5 to 2.5 mm (1/16 to 1/10 in) in length) which have been given the name "eye gnats" or "eye flies" because of their predilection for eye secretions. They are also attracted to wounds, pus and sebaceous secretions. They are extremely annoying to man because of their persistent habit of swarming closely about the face. Although these flies are incapable of piercing the skin to take blood, their mouthparts are equipped with upturned spines which act as fine cutting instruments. With these structures, they are able to abrade the edges of sores and the conjunctival epitheliums. The life cycles for many *Hippelates* spp. are not completely known. However, generalizations may be drawn from what is known about *Hippelates colusor* Breeding continues year round but at a lower rate in winter. The eggs are deposited at weekly intervals in batches of 50 or less on or below the surface of loose, well aerated non-putrid soil, which may contain fecal material and/or plant material. The average incubation time under optimum conditions (32 degrees C/90 degrees F) is about 2 days. The larvae feed on decaying organic material, including feces, and complete development in about 7 to 11 days. Pupation takes place close to the surface in the larval feeding medium and lasts 6 to 7 days.

(3) *Control of domestic flies.* Successful control of domestic flies, when necessary, depends upon improved environmental sanitation in conjunction with selected application of insecticides. Prevention of fly breeding and entry into buildings reduces the potential for disease transmission and, simultaneously, increases the impact of any chemical used in reducing fly numbers.

(a) *Sanitation.* Effective sanitation measures and proper policing of grounds are of primary importance in

fly control. This is particularly relevant in view of the increasing amount of insecticide resistance problems. With proper sanitation, less dependence need be placed on insecticides. Any fermenting or decaying organic matter, including human and animal feces, dead animals, fish and meat refuse, and discarded food stuffs, are potential breeding places for flies. Therefore, the elimination of all sources of attraction for flies is essential. Proper disposal of food service wastes, including all garbage and such liquids as wash water, reduces the attraction of flies to the dining facility area. Garbage should be deposited in well covered containers which, when empty, should be washed regularly. These containers should be kept outside of dining facilities and preferably off the ground on a stand or rack. Effective disposal methods must be used for garbage, nonsalvable compressible waste, and rubbish.

(b) *Chemical control.*

1. *Control of immature stages.*

a. *General.* Larviciding usually is not practical in a large operation because breeding places are too scattered for effective treatment. However, this method is indicated for control in areas of concentrated breeding, such as garbage-handling zones, livestock and poultry farms, and piles of compost materials and carcasses. In all larvicidal treatments, emphasis must be placed upon getting the insecticide to the site where it can act upon the larvae. Extensive reliance on larviciding should be avoided since it probably precipitates the development of resistance. Latrine structures should be treated with residual insecticides. Human excrement in latrines normally does not produce many *M. domestics* because they do not propagate well in the semiliquid media. On the other hand, the pestiferous and myiasis-producing soldier fly, *Hermetia illucens,* breeds prolifically in the semiliquid material in untreated latrines. When insecticides are used to destroy *H. illucens* larval populations, the media becomes semisolid in nature and, thus, suitable for house fly breeding. House flies, frequently having insecticide resistance, are not always affected by treatment and usually increase in prevalence.

b. *Insecticides.* Larvicides should be applied until the breeding medium is saturated to a depth of 50 to 75 mm (2 to 3 in). This usually requires large amounts of dilute spray. Since most larvicides also act as adulticides, spray applications should be directed to locations where the emerging adults will contact the chemical as they attempt to leave the breeding material. In most cases adding sugar to the spray enhances the insecticidal activity of these insecticides by functioning as a fly attractant which will lead to considerable adult fly control. Where the pit latrine contents are relatively dry, fly breeding can be controlled by sprinkling PDB over the pit surface at the rate of approximately 60 gm (2 oz) per latrine per week. This treatment is effective only when pits are deep, dry and unventilated. Application of PDB at a rate of 60 gm per garbage container for home use gives control for 1 to 2 weeks.

2. *Control of adults*

a. *Residual application.*

1. *General.* Should sanitation measures for fly control be found inadequate, application of residual insecticides to areas of fly congregation may be necessary to provide a satisfactory level of control. The surface areas to be treated include resting places in buildings, such as overhead structures, hanging cords, moldings, door and window facings, tent lines and tent exteriors. Resting places, such as building exteriors near breeding sites, open sheds, garbage cans, shrubs and low trees may also be treated with residual insecticides. For best results the places to be treated should be determined in advance and application should be made only to the actual resting sites. These sites can best be determined with a flashlight at night and by looking for the presence of "fly specks." Spray equipment with a fan-type nozzle is recommended for residual applications, and surfaces should be wetted to the point of runoff. Paint brushes and rollers can be used.

2. *Insecticides.* Several insecticides can be applied as selective spot treatments, and will provide good indoor control for about 1 week. Outdoors, if necessary, insecticides may be effectively sprayed on exterior surfaces around garbage cans, garbage racks and screens. When spraying, do so to the point of runoff, avoid contamination of food or utensils, and do not use sugar mixtures. Do not permit personnel or utensils to contact wet treated surfaces.

a. *Aerosol space spraying and area treatment.* Where residual and larvicidal applications and environmental sanitation fail to give satisfactory fly control, space sprays, dispersed as aerosols, can be used effectively for the prompt elimination of flies inside buildings. They have no lasting effect; frequent retreatment is necessary. The use of vaporizers is prohibited. Aerosols may be used for area treatment outdoors when flies are active. Several insecticides, if properly used as ULV (Article 8-11(4)(b)) aerosols, will provide fly control 100 m or more from the point of release when the ULV equipment is calibrated to deliver droplets which meet label specifications.

b. *Poison baits.* In certain situations poisoned baits may be used effectively in the control of adult flies. Basic formulations of both liquid and dry baits consist of a strong toxicant and a fly attractant. General use of baits in an area is not desirable. Bait applications should be used where large concentrations of flies are observed. The frequency of the application depends largely upon the existing fly potential. Where the potential is high, repeated applications, even daily, are necessary. Usually the need for routine treatment stops after several weeks. Consequently, the frequency and amount of bait used can be reduced.

c. *Miscellaneous control methods.*

(1) *Screens.* Screens are a necessary aid in preventing flies from coming in contact with personnel, food and drink. The use of adulticides is much more effective where adequate screening exist. Screens should have an 18 x 18 mesh, screen doors should be designed to open outwards, and should be in direct sunlight whenever possible.

(2) Fans. High velocity electric

fans, properly placed over doors or in positions that blow a direct air current against the doorway, tend to prevent flies from entering when the doors are opened. If the fans are properly placed they can be useful as a supplementary method of fly control in places where doors must be opened repeatedly (e.g., food service facilities).

(3) *Fly paper.* This material may provide a useful index of fly populations during survey or investigational work, but it is relatively ineffective as a control method.

(4) *Baited traps.* Many types of baited traps have been developed for fly control but they do not provide adequate control where heavy fly populations exist.

(4) *Control of stable flies (Stomoxys* spp.)

(a) *Sanitation.* The first and most important step in the control of S. *calcitrans* is destruction or removal of their oviposition sites. Since stable flies breed in all types of damp decaying vegetable matter, this process involves finding the breeding places and then either destroying these sites or making them inaccessible to the flies. Where breeding is occurring in agricultural waste (e.g., straw, manure and other organic refuse), standard recommended practices should be used for proper storage or disposal of these wastes. For example, they should either be kept dry or spread so thinly that they will not support fly breeding. Stable flies commonly breed in decomposing seaweed that is washed into windrows on ocean beaches above normal tide levels. Disposal of this material generally is not practical, thus, necessitating selective larvicide use. The extent and frequency of larviciding can be reduced by careful surveys because it is known that any accumulation of seaweed that is submerged for 6 hours or more during the 2 week period required for development of the immature stages will not require chemical treatments. Such submersion is natural sanitation and kills most of the larvae and pupae.

(b) *Chemical control.*

1. *Control of immature stages.* Breeding may be controlled by thoroughly wetting the breeding material with an approved larvicidal spray where no direct threat to aquatic wildlife exists.

2. *Control of adults.* A number of insecticides are effective against more than one genus of fly, but the method of application would be different for each. For example, adult stable flies may be killed with the same materials and in the same manner as recommended for house flies, except that poison baits are not effective. Where these flies cause human discomfort and control measures are not feasible, such as protection of troops in the field, personal application of diethyltoluamide (DEET), a standard insect repellent, is recommended (see Article 8-47).

(5) *Control of tsetse flies (Glossina* spp.). Because of the diversity of habits among tsetse flies and the practical absence of a free-living larval form, they are difficult to control. Among the many modes of control that have been or are being utilized are: traps, natural enemies (biological control), cover modification, control of host game animals, establishment of fly barriers consisting of clearings or thickets that would inhibit fly movement and/or reproduction according to the species involved, and quarantine areas. Aerosol space sprays have also been used effectively for adult control. Entire river courses have been treated, causing a reduction of up to 99% in adult *Glossina palpalis. Glossina morsitans* normally does not breed along rivers and is more difficult to control because of large areas of forest that must be sprayed. Quarantine areas have been set up in various parts of Africa which consist of barriers along roads. Vehicles proceed rapidly through infected districts with all windows closed. When the vehicles have left these quarantine areas, they are examined and all flies found are killed. The results of this control program have been good.

(6) *Control of sand flies (Phlebotomus* spp.). Sand flies have a very short flight range so elimination of potential breeding sites near an infested area will give relatively good control within a limited area. Elimination of these sites may include complete drainage and drying to remove moisture necessary for development. Stone and rocky areas may be covered with dirt; rock walls and stone masonry may be either destroyed or faced over with mortar to eliminate cracks and crevices. The flight habits of phlebotomine flies render the species vulnerable to the application of residual sprays. The adult flies frequently rest on outer walls before entering a building. They enter by a series of short, hopping flights with relatively long pauses. Once inside, they may linger for a time on the walls before seeking a blood meal source. Application of residual sprays with the equipment and dosages recommended for house flies and mosquitoes is suitable for the control of sand flies. Sleeping quarters and rooms occupied after dark should be treated as well as doors, windows and screens. An even greater margin of protection is obtained by spraying the outside of doors, windows and ± 0.5 m of the wall surrounding these openings. The application of residual spray solutions to the interior surface of tents and around the openings, including the flaps, bottom edges and ventilation openings is also recommended. Emulsion formulations should NOT be used on tents because they will break down the water proofing and cause tents to leak during subsequent rains. In some situations, local area control may be expanded by extending the spraying program to include outdoor applications of residual insecticides. This will deny the sand flies the customary outdoor shelters and/or breeding places, and present lethal barriers between the adult flies and the buildings to be protected.

(7) *Control of biting midges.* For these flies, it must be determined whether the problem is serious enough to warrant control efforts because they are seldom completely successful. The most effective control is obtained while they are in the immature stages because at that time they normally are clustered. However, for biting midges, it is difficult to determine where breeding is occurring because of their habit of developing in the soil. In addition, the larvae are very small. Very careful survey work with soil flotation methods is necessary to demonstrate the presence of the larvae. This procedure is tedious and, even in the hands of experts, subject to a

considerable number of false negatives. Any serious attempt to effect control of human biting midges must be preceded by an extensive and careful larval survey. Where the area supporting larval breeding can be determined, control of larvae can be obtained by the direct application of insecticides to the soil. This is an expensive procedure because control must be done on an area basis at periodic intervals to eventually eliminate entry by adults from surrounding uncontrolled areas. Such treatments must be thorough and, consequently, are also injurious to many forms of aquatic life. These treatments may also lead to a rapid buildup of insecticide resistant flies. Aerosol space spray treatments against the adults, which will be described below for black flies and mosquitoes, is possibly the most effective control measure presently available for bringing relief to small groups of people. The camp and personnel protective measures recommended for mosquitoes (Article 8—35 and 847 respectively) are all equally effective against biting midges. Their extremely small size must be kept in mind wherever mesh or fabric screening is to be used. In order to exclude biting midges, 20 mesh screening is required; however, this will seriously interfere with ventilation. Because of this problem, insecticide treatment of screens can provide considerable control and relief against flies lighting on or passing through them. A deficiency in this control method is that the insecticide on the screen is eventually covered with windblown dirt and dust particles.

(8) *Control of black flies (Simulium* spp.). Black flies are effectively controlled by the application of larvicides to the streams where the immature forms are developing. Where only one brood of black flies emerges annually, a single treatment of streams should markedly reduce the fly population. If multiple generations are produced, the number of treatments should correspondingly be increased. Stream treatment should only be initiated when necessary to protect public health. Because of the long flight range of black flies and heavy population pressures adjacent to the control area, aerosols or mist sprayers cannot be depended upon to provide adequate control. Although the biting rate of black flies is usually much lower than that of mosquitoes, personal protective measures against them are considered to be essential. Generally, the measures described for protection against in-quarters mosquito bites (Article 8—35) apply equally to black flies. Characteristically, black flies crawl beneath clothing whenever the opportunity presents. Therefore, tight-fitting cuffs and collars are important in preventing their bites. Protective netting and fabric must be a minimum 20 mesh per inch and 28 mesh for standard wire or fiber.

(9) *Control of horse and deer flies (Tabanus* spp. *and Chrysops* spp.). Control of these pests is difficult and frequently ineffective. Space applications of insecticides similar to those recommended for mosquito control may be effective under some conditions, particularly if applications are made when the adult flies are active. In areas of heavy populations of *Tabanus* and *Chrysops,* the use of adulticides has not proved to be overly satisfactory. The use of larvicides has the same drawbacks as described for the larval control of biting midges. The personal protective measures described for mosquitoes (Article 8—35) are fairly satisfactory for protection against these flies, except that current standard repellents are not always successful. Horse and deer flies will occasionally enter quarters, but not for biting, consequently, protection while in quarters is not a problem.

(10) *Control of eye gnats (Hippelates* spp.). The eye gnat species, *Hippelates pusio* and *H. collusor, are* the most troublesome to man within the United States. Efforts to effectively control these species by the use of aerial and ground delivered sprays and aerosols have generally been unsuccessful. Because these flies commonly breed in fresh turned soil, successful control can sometimes be accomplished by modifying agricultural methods. This would include conversion of crop land to pasture and shallow disking when cultivation is necessary. Soil application of insecticides may have some promise. However, the success of the methods of agricultural and insecticide control is contingent on the biology of the flies, but all of the life cycle information is not yet known. Where eye gnat problems are encountered and in the absence of control measures known to be successful locally, the assistance of appropriate technical personnel should be obtained.

8-35. **Mosquitoes**

(1) *Relation to man.* Mosquitoes rank first in importance among the insects that transmit disease to man. This is partially because their biting habits vary among genera and species with regard to habitat, time of day, and host type and availability. This variability is important because it causes exposure to and subsequent transmission of different disease organisms (e.g., periodic and nonperiodic filarisis). The genera most frequently associated with disease transmission are *Aedes, Anopheles* and *Culex.* Disease organisms vectored by mosquitoes to man include bacteria (tularemia), arboviruses (dengue, encephalomyelitis (Eastern, Western, St. Louis, Japanese B, and Russian Spring-Summer) and yellow fever), protozoa (malaria), and filarial nematodes *(Wuchereria bancrofti, Brugia* spp., and *Dirofilaria immitis).* Besides serving as disease vectors, many species of mosquitoes are serious pests of man solely because of their irritating bites.

(2) *Biological characteristics.* Mosquitoes oviposit on the surface of water or on surfaces subject to flooding. Larvae hatch and feed on organic matter in the water, pupate, and eventually metamorphose into adults. Mosquitoes utilize a great variety of water sources for breeding. These include ground pools, water in artificial containers, water-holding tree holes and leaf axils. Adult mosquitoes, when not actively seeking food, rest in concealed places. Only the females feed on blood. Depending upon the species involved, the distance of dispersal from breeding areas varies from a few meters to many kilometers. Males normally do not fly long distances from breeding areas; consequently, any uncommonly large

concentration of males usually indicates that the breeding area is near.

(3) *Surveillance of mosquitoes. See* Article 8-60 for details on collection.

(4) *Control.* Mosquito control methods are classified as being either permanent or temporary depending upon whether they are designed to eliminate breeding areas or simply to kill the present population. Aside from the elimination of artificial water holding containers in campsites, permanent control measures have a high initial cost and require considerable periods of time to complete. Permanent mosquito control measures are considered in detail in NAVFAC MO-310; consequently, only temporary control methods are presented below.

(a) *Control of immature stages.* Temporary control of mosquito breeding is accomplished by treating water surfaces with larvicides. Larviciding equipment is described in Section VIII of this chapter.

1. *Ground larviciding.* Where no larval resistance to insecticides has been documented, solutions, emulsifiable concentrates, granules, and water-dispersible powders may be used effectively for larviciding with ground-operated equipment. The use of granules is indicated where a heavy vegetation cover must be penetrated or where possible damage to crops (e.g., rice) is a consideration, Because the percentage of toxicant and application rate vary with the type of equipment used, species of mosquito involved, geographical area considered, and with the degree of resistance developed, current recommendations should be obtained from appropriate technical personnel (Article 8-4 and 8—5).

2. *Aerial larviciding.* OPNAVINST 6250.4 defines the use of aircraft for the dispersal of insecticides which will not normally be approved unless recommended by a Navy Medical Entomologist or a NAVFAC Special Assistant for Applied Biology. The responsible naval commander in overseas areas is authorized to approve aerial dispersal of insecticides by naval aircraft when he considers such dispersal to be justified and the operation is to be supervised by qualified personnel. Aerial dispersal for mosquito control will ordinarily be justified in the continental United States and other developed areas only under the following conditions

a. Where permanent control measures (e.g., drainage, filling) cannot be accomplished economically.

b. Where there is no access to ground dispersal equipment.

c. Where screening, repellents, space sprays and residual treatments are not adequate to control vector borne diseases or to increase work efficiency.

d. Where ground application of aerosols, mist or other insecticidal formulations are ineffective in reducing or controlling heavy populations.

e. Where it is economically more practical to treat a major breeding area with aircraft rather than ground control equipment.

3. *Control in water containers.* Containers, such as empty cans and old tires in which mosquito larvae may breed, should be eliminated if possible. Those that cannot be eliminated should be treated with a larvicide to control and prevent breeding.

(b) *Control of adult mosquitoes.* Adult mosquitoes may be controlled by the application of residual and space sprays.

1. *Indoor control.* Space sprays are recommended for interior control of mosquitoes when immediate eradication is required. Space sprays can be effectively applied with an aerosol dispenser. Treatment with the standard aerosol dispenser should be at a rate of 10 seconds of discharge per 300 cu m (1000 cu ft) of space. Space sprays have little or no residual effect and must be reapplied whenever new mosquitoes enter the space. Where frequent re-entry is a problem, or where disease bearing mosquito species are involved, it becomes necessary to apply residual sprays to the surfaces on which mosquitoes are likely to rest. Residual sprays differ from space sprays principally in possessing a greater concentration of the toxicant material. Only insecticides with long lasting effects are suitable for use in residual sprays. Where rough absorbent surfaces are involved, the use of a suspension made by mixing a water-dispersible powder is more effective than the use of either a solution or emulsion. When resistance to an insecticide is suspected, contact the nearest entomologist for assistance or advice. Equipment required for residual and space applications is described in Section VIII.

2. *Outdoor control.* Treatment using aerosols or mists is recommended for the outdoor control of adult mosquitoes. When control of breeding sources is not possible, aerosols are considered to be a desirable method for preventing annoyance by mosquitoes in limited bivouac areas. Aerosols will often effect complete control within a limited region and will bring adequate protection for short periods. However, in any area where reproduction is continuous and dominated by migratory species, the use of aerosols alone is satisfactory only if done on a repetitive basis. When properly applied, aerosols do not leave dangerous or unsightly deposits. Where reinfestation is not a problem, such as in less populated areas, insecticide application by means of a mist blower may provide satisfactory control.

a. *Aerosol utilization.* Aerosol operations should be accomplished when wind speeds are less than 6 knots and when a temperature inversion is present. Since aerosol applications are most effective against flying insects, they should be accomplished when the target species are active.

b. *Residual sprays.* Residual sprays have a limited exterior applicability for the protection of small camps. When used, the spray is applied to all vegetation surfaces for an area of 30 meters or more around the place to be protected and to insect resting places within the bivouac area.

(5) *Protective measures*

(a) *Screening.* Living quarters in permanent or semipermanent camps should be protected with 18 mesh screening. Where vector species are present, bed nets should be used as additional protection.

(b) *Personal protection.* Personal application type insect repellents are discussed in Article 8—47.

(c) *Camp location.* In areas where disease bearing mosquitoes occur, zones outside the camp perimeter

should be off-limits to all military personnel, except as required. Furthermore, care must be exercised to locate camps as far as possible from native villages to avoid contact with potentially infected mosquitoes.

(d) *Chemoprophylaxis.* Routine administration of chemoprophylatic drugs is essential in malarious areas as a supplement to vector control (NAVMEDCOMINST 6230.2). The diagnosis and treatment of indigenous personnel with malaria is an important factor in limiting the foci of the disease and providing an additional means of reducing the exposure of landing forces.

8-36. Lice

(1) *Relation to man.* The infestation of lice on a human host is termed pediculosis. Human lice are responsible for the transmission of louse-borne typhus, trench fever and louse-borne relapsing fever. Louse-borne typhus, a historical medical problem, is one of the few serious insect transmitted diseases in which man serves as the infection reservoir. Trench fever is thought to be related to typhus fever. It does not kill, but it can be a debilitating epidemic disease among louse infected troops. Louse-borne relapsing fever is caused by a spirochete. Although found throughout the world, it is most prevalent in parts of Europe, North Africa and Asia. In addition to serving as the vector of these serious diseases, lice cause a great deal of misery for infested people. Human louse species do not normally infest other animals.

(2) *Biological characteristics. Three* species of lice infest man: the head louse, *Pediculus humanus capitus,* the body louse, *Pediculus humanus humanus* and the crab louse, *Pthirus pubis.*

(a) *Human louse. The* body louse, *P. h. humanus,* and the head louse *P. h. capitus* are quite similar, differing principally in the part of the body normally occupied. The body louse is found upon the body, spending much of its time attached to the undergarments. The head louse is found upon the head and the neck, clinging to the hairs. The egg of the body louse is attached to fibers of the underclothing, whereas, the egg of the head louse, a "nit," is cemented to the hair. The eggs of the human louse are incubated by the host's body heat and hatch in about a week. Hatching is greatly reduced or prevented by exposure to temperatures above 37.8 degrees C (100 degrees F). Thus, it is apparent that regular washing or dry cleaning of clothes provides a reliable control method. Immature lice resemble the adult in body form and become progressively larger as development takes place. Frequent blood meals from a host are required. Lice die within a few days if prevented from feeding. Head and body lice are normally acquired by personal contact, by wearing infested clothing, or by using contaminated objects such as combs and brushes.

(b) *Crab louse.* The crab louse is primarily found upon hair in the pubic and anal regions, but on occasion may be found in the eyebrows and other areas of the body. This insect feeds intermittently for many hours at a time and is also unable to survive more than a short time away from the host. Crab lice are spread mainly by physical contact, but also maybe acquired from toilet seats or objects recently used by infested individuals.

(3) *Control.* Control includes delousing of individuals, treatment of infested clothing, bedding, living areas and toilet facilities, and the prevention of new infestations. Human louse control measures should be coordinated with a medical officer.

(a) *Preuentive measures.* The following preventive measures, especially during crowded shipboard and tenting or refugee operations, should be taken:

1. Avoid physical contact with louse infested individuals and materials.

2. Observe personal cleanliness, i.e., at least weekly bathing with soap and water and clothing changes (particularly underclothing).

3. Avoid overcrowding of personnel.

4. Instruct personnel on the detection and prevention of louse infestation.

(b) *Individual treatment measures*

1. *Insecticides.* Louse insecticide powder NSN 6840-00-242-4217 in 2 oz. shaker can is issued for individual use.

2. *Body louse.* For prevention or treatment of body louse infestations, wash all clothing and bedding in hot water and repeat in 7 to 10 days. If washing of clothes is not practical because of travel or combat, an insecticidal dust is recommended. Dust the entire surface of underwear and any other clothing worn next to the skin, including the shirt, as well as along the seams of outer garments. Rub the treated clothing lightly to spread the powder. About 30 gm of insecticide per person is required. If clothing cannot be conveniently removed, unbutton the shirt and trousers and dust the powder liberally on the inside of the underwear or other garments next to the skin. Then pat the clothes by hand to ensure distribution of the powder. Since extra clothing, bedding and toilet facilities serve as sources of reinfestation, these items should also be dusted.

3. *Head louse.* For head lice, apply the powder lightly to the hair and rub it in with the finger tips. Do not wash the hair for at least 24 hours. Since the eggs are not killed by the insecticides, second and third applications are necessary at weekly intervals for full effectiveness. Insecticidal shampoos are quite effective and available at military pharmacies.

4. *Crab louse.* For crab lice, apply the powder thoroughly to all regions of the body having a moderate to heavy growth of hair. Do not bathe for at least 24 hours. One or two repeat treatments at 10 day intervals may be necessary. Insecticidal ointments and shampoos are also available and quite effective.

(c) *Mass delousing measures.* If 50 percent or more of the unit personnel are infested, mass delousing measures should be taken.

1. Delousing powder is available for use in mass delousing with hand and power dusters.

2. For small operations the plunger-type hand duster is suitable. This item is equipped with an extension tube and delivers an even flow of powder. One duster ¾ full holds enough powder to treat approximately

10 individuals. Best results are obtained when dusters are not completely filled.

3. For large operations, power dusting equipment is recommended. The use of this type of equipment" is especially suited for treating infested persons at military installations, troops in rear areas, prisoners of war, civilians adjacent to troop concentrations in occupied territory and personnel boarding transports for overseas destinations. Where power dusting equipment is used, about 100 lb of dusting powder will be required for each 1,000 men to be treated. Additional powder would be required for extra clothing and bedding.

4. Dusting of personnel should follow a definite routine to avoid missing portions of the clothing. A suggested procedure, which may be modified as the situation warrants, is outlined in the following steps:

a. Direct personnel to loosen collar, tie and belt and to stand with hat in hand.

b. Dust the head first, separating the hair with the fingers to ensure even distribution. The hair should be whitened with the dust.

c. Dust the inside of the hat.

d. Insert nozzle into right sleeve next to the skin. With subjects arm outstretched to the side at shoulder height, direct powder toward the armpit. Hold the trigger of the powder duster down until powder is seen to issue from the loosened neck of the shirt. Repeat for the left sleeve. The subject's face should be turned away from the side being dusted.

e. Insert the nozzle in the front of the shirt at collar and direct the powder toward the right armpit, the stomach and the left armpit. The operator stands in front, and the subject leans forward with head tipped back.

f. Insert the nozzle in front of the trousers, next to the skin and direct powder towards the right leg, the pubic region and the left leg.

g. Insert nozzle in the back of the shirt at the collar and direct the powder toward the right shoulder, the small of the back and the left shoulder. The operator and the subject remain in same relative position as above, but with the head of the subject bent towards the chest. Powder should be dusted on the collar itself where lice frequently are found.

h. Insert nozzle in the back of the trousers, next to the skin and direct powder towards the right leg, the buttocks crease and the left leg.

i. When using hand dusters, two full even strokes in each position are required. With power dusters a momentary pressure on the trigger is usually all that is necessary. In dusting women wearing dresses or skirts, the clothing is first loosened at the waist. Dust is blown in at the sleeves and collar.

j. Because extra clothing and bedding serve as a source of reinfestation, they should also be dusted.

8-37. **Bedbugs** *(Cimex* spp.), **Shipboard and Ashore**

Bedbugs infest warm blooded animals including man and are occasional pests aboard ships. They are not known to vector human diseases, but they are annoying and can seriously affect morale. Bedbugs are approximately 6 mm (1/5 in) in length, flat, reddish-brown and wingless insects with sucking mouthparts. They have nocturnal movement and only feed on blood. Their bite usually produces small, hard, white swellings (wheals). Bedbug infestations are not necessarily associated with unsanitary conditions. They are often transported to clothing, baggage and laundry and may be easily introduced into very clean quarters. Habitual hiding places of bedbugs, such as in the seams of mattresses, will often be obvious by the presence of dried black or brown excrement stains on surfaces where they congregate and rest. Their presence may also be indicated by blood stains on the bedding. For control, light applications of an appropriate insecticide recommended by the area entomologist should be made to the sides and seams of mattresses, which are best treated by folding and placing them in the center of the bunk at a 45 degree angle. Other sites to be sprayed should include cracks and corners of the bunks, empty lockers, springs, canvas bottoms and grommets, stanchions and behind all equipment close to bulkheads. Bunks may be made up and occupied after 4 hours of ventilation following application. Complete control should be expected within 10 to 14 days.

8-38. **Cockroaches, Shipboard and Ashore**

(1) *Relation to man.* Cockroaches are probably the most common and persistently troublesome arthropod pest encountered indoors. They are among the most adaptable insects known. It has never been demonstrated that cockroaches directly vector pathogenic organisms. But significant circumstantial evidence indicates that cockroaches maintain and disseminate pathogens. Bacteria, viruses and protozoa have been isolated from them or their feces. Because of their habits and close association with man, they are well adapted for mechanical transmission of diseases such as amebiasis or other gastrointestinal disease organisms. This discussion is designed to provide information for effective control of cockroaches whether they are located aboard ship or ashore. Considerations concerning cockroach infestations include the following

(a) They are considered an indication of substandard sanitation by most people.

(b) They often cause anxiety and repulsion and may lead to entomophobia (fear of insects) which is of special consideration in regard to hospital patients' comfort and recovery.

(c) Cockroaches habitually disgorge portions of partly digested food and defecate wherever they go. They also discharge a nauseous secretion from oral and abdominal glands which leaves a persistent and typical "cockroach odor" on all surfaces contacted.

(d) Cockroaches defile, contaminate or damage food, linens, books, utensils and other supplies and equipment.

(2) *Responsibility for shipboard cockroach control. The* shipboard medical department has been charged with

responsibility for pest control operations. Harbor craft and small vessels without a medical department representative should obtain assistance from the medical department and/or pest control shop of their local activity.

(3) Cockroach biology and identification. An understanding of the habits and life history of the cockroach is a prerequisite to successful control. Those which are briefly described here are the most notorious from the standpoint of frequency and size of populations and affinity for indoor habitats. This is true regardless of climate or elevation since heated buildings and ships provide a relatively constant environment acceptable to the cockroach. They are omnivorous, adapting well to a variety of food sources, and prefer to be active under subdued lighting conditions.

(a) *German cockroach, Blatella germanica*

1. *Appearance. The* late egg stage is passed in a dark yellowish brown to tan colored capsule or egg case which is carried, protruding from the abdomen, by the female for about two weeks until, or shortly before, the eggs hatch. The female produces an average of 6 capsules, each containing up to 50 eggs. The young (nymphs) pass through seven molts in 40 to 60 days. The life span is 6 to 10 months with 2 to 4 generations per year. The adult is tan or straw colored, about 15 mm long and distinctively marked with two longitudinal dark stripes near the head.

2. *Habits.* This is the most common indoor species, especially in and around food service spaces and facilities. Infestation is a recurring problem in galleys, messhalls, exchange snack bars and cafeterias, coffee messes, bakeries, butcher shops, vegetable preparation rooms and potato lockers. It frequently occurs in hospital wards in diet kitchens, food service carts, bed stands, lockers, soiled laundry hampers and washrooms. Because of its size and wide distribution, the german cockroach is easily carried into the hospital with provisions, especially fresh produce, bakery goods, soft drink cases, food and drink vending machines and even laundry. This cockroach frequents secluded cracks and crevices in the walls, wood and metal trim, fixtures, electrical appliances, furnishings and other similar places.

(b) *Brown-banded cockroach, Supella longipalpa*

1. *Appearance.* The dark reddish-brown egg capsules, containing an average of 15 eggs, are securely glued by the female in cracks, corners and angular locations in furnishings, fixtures, clothing and draperies where hatching takes place. Each female produces an average of 10 egg capsules. The young pass through 6 to 8 molts in about 3 months. This species is lighter in color and slightly smaller than the German cockroach, being somewhat less than 15 mm long. Two light yellow cross bands near the base of the adult's wings and two transverse light bands on the dorsal surface of the nymphs give this species its name. The female is quite broad with short wings while the male is more slender with the wings extending beyond the tip of the abdomen.

2. *Habits.* The brown-banded cockroach prefers living rooms, dining rooms, and bedrooms and closets of dwellings. It is a common pest in hotels and motels and is often found on hospital wards. It is more secretive and less obtrusive in habits than other cockroach species, hiding in cracks of woodwork, furniture, drawers, lockers, wardrobes, closets, beds and draperies. It may infest all parts of the premises. It is not considered a "food service area" species as is the German cockroach.

(c) *American cockroach, Periplaneta americana*

1. *Appearance.* The dark reddish-black egg capsules, containing an average of 15 eggs, is firmly cemented to various substrates and often covered with debris. An average of 34 capsules are produced by each female. The young emerge in approximately 35 days and molt 9 to 13 times over a period of 10 to 16 months before finally becoming mature. Hence the life cycle takes an average of 14 months and the total life span may take as long as 2.5 years. The adult is dark reddish-brown, approximately 35 mm long and the anterior dorsal plate behind the head has a conspicuous yellow posterior border strip.

2. *Habits.* This cockroach has particularly filthy habits, frequently moving from shelters or breeding areas to food sources. It favors, and becomes abundant, in such places as damp basements, restaurants, bakeries, packing and slaughter houses, food stores, crawl spaces under dwellings and other buildings, and sewage disposal plants. It often occurs in very large numbers in dumps; sewage manholes and conduits; and in steam tunnels and other subfloor conduits in galleys. Therefore, its requirements for subsistence are met where there is a combination of food, warmth, dark seclusion and high humidity. As previously noted, it commonly leaves these environs in search of food which makes the American cockroach a potentially dangerous disease vector. Its presence is often first recognized by finding its hard, dark, 3.2 mm (1/8 in) long fecal pellets.

(d) *Australian cockroach, Periplaneta australasiae* This species is quite similar in appearance to the American cockroach except that the adults have a yellow strip along one third of the outside margin of the forewings and is approximately 32 mm in length. The habits of this cockroach are similar to those of other cockroaches; however, it is not commonly found indoors and has a more limited distribution. This cockroach can be particularly objectionable because of its unsightly, liquid, fecal droppings.

(e) *Other cockroaches.* Several other species of cockroaches occasionally infest premises and include the following Oriental cockroach, *Blatta orientalism;* Florida woods cockroach, *Eurycotis floridana;* brown cockroach, *Periplaneta brunnea;* smokey-brown cockroach, *Periplaneta fuliginosa;* and Surinam cockroach, *Pycnoscelus surinamensis.* The more common cockroaches are identifiable by the general descriptions in this chapter. Descriptive characters of other important, but less frequently contacted species, can be found in readily available medical entomology manuals. In all instances, the target species should be identified before proceeding with control measures.

(4) *General control.* If the overall absence or near absence of cockroaches is to be achieved, it is essential that both sanitary and chemical control measures be

established on a preventive rather than on a "trouble call" basis. Preventive control requires frequent inspections and thorough surveys. Prevention also includes good sanitation, prevention of entry, elimination of harborages, supplemental chemical control when indicated.

(a) *Sanitation.* Active food preparation areas cannot be kept clean enough to eliminate existing cockroach populations by starvation. However, the following sanitation practices are of proven value:

1. All food materials should be stored so as to be inaccessible to cockroaches.

2. Garbage and other refuse should be placed in containers with tight-fitting lids and removed daily.

3. All food preparation areas, utensils and equipment should be thoroughly cleaned after each day's use.

4. Foods should be restricted in berthing areas.

5. Cleanliness reduces available food for cockroaches and may determine the degree to which the population expands. As the level of sanitation increases, the level of cockroach infestation decreases.

6. Reduction in food sources and general cleanliness may cause the population to forage further, thus, increasing the probability for cockroaches to encounter residual insecticides.

(b) *Prevention of entry.* Although primarily important for ship's stores, items such as bagged potatoes and onions, bottle cases and food packages must be inspected prior to storage or use to avoid reinfestation by cockroaches. Since cockroaches may be transported in egg, nymph or adult stages, care in inspection is necessary.

(c) *Harborage elimination.* Cockroaches do not normally inhabit structures which lack suitable hiding places. As harborages are eliminated, populations are reduced and the use of chemicals becomes more effective. The sealing of cracks and crevices and general elimination of harborages is extremely important in cockroach control. Typical harborages include the following

1. Old and torn insulation.

2. Holes for plumbing and electrical lines, as well as electrical switches and fuse boxes.

3. Areas between walls (false bulkheads).

4. Areas behind drawers, oven hoods, under counters and serving lines.

5. Hollow legs (e.g. stove legs and refrigeration and heavy equipment supports).

(d) *Chemical control.* Complete reliance on chemical control would be undesirable even if completely effective because this method is meant to supplement sanitary control measures. Some aspects of chemical control include:

1. *Residual application.*

a. Crack and crevice treatments in food preparation and service areas.

1. Random spraying will not give good cockroach control. The insecticide must be applied where the insect lives. Therefore, most spray applications will be made to cracks and other harborages where cockroaches have been found during the survey. For this type of application use a low pressure fine pin stream aimed directly into the crack. The angle of application is important because the greater the angle of the stream to the crack, the more reduced will be the amount of insecticide that will penetrate. Crack and crevice treatment with pin stream applications offers the additional advantage that the insecticide material is less likely to be washed away during routine cleaning procedures.

2. *Barrier treatment.* Barrier treatments may be used only in non-food preparation areas. While using a flat fan nozzle and high pressure, apply a band or barrier of insecticide residual around all areas that cockroaches must cross to reach food or to travel from place to place (e.g., around hatches, pipes, vents, overhead wiring, openings through overheads, bulkheads and decks and areas where cockroaches have been found during surveys). Pay particular attention to areas with overhead wiring which are often major sites of infestation.

3. *Bait application*

a. *General application.* Insecticide bait can be used in fuse boxes, electrical outlets, around stoves, ovens, heaters, refrigeration units, food vending machines, behind false bulkheads and enclosed motor areas. If other treatment choices are available use them first. Use baits only as a last resort in selected areas. Baits can be used in all locations where liquids present the danger of electrical shorting or fire. Avoid placing baits in overhead areas where bait would fall into food preparation areas. Bait should be kept dry to be effective. Remove and replace every two months or as required.

b. *Bait stations.* Use bait stations such as Combat™ to complement other treatment methods.

4. *Contact powder application..* Location and treatment the same as with baits. This material can additionally be used behind false bulkheads. Considered very effective and long lasting as long as powder remains dry.

5. *Aerosol ULV application.* Food service areas and other infested compartments can be effectively treated with aerosol space sprays. The success of this method depends on proper insecticide dispersal equipment and the insecticide formulation. Use of this method will usually take place only under *special circumstances* and it must be authorized by the area entomologist. Aerosol use is not meant to replace residual sprays. This technique should not be confused with the use of the 12 oz. aerosol cans.

a. *Preparation of spaces for aerosol treatment.* Most of the time spent for this control method is used to prepare and maintain an air tight seal in the treated spaces.

1. The spaces to be treated shall be thoroughly cleaned. Particular attention should be paid to collections of grease on and around counter tops, deep fat fryers, vents and food serving lines.

2. Secure all areas to be treated and evacuate all unnecessary personnel except those conducting the spray operation.

3. Put all exposed foods into protected compartments. Remove all cooking utensils from the space before treatment.

4. Open all cabinet doors.

5. Open all drawers in a stair step fashion with the bottom drawer removed and placed on the floor.

6. All hatches which do not have covers or cannot be adequately sealed must be fitted with a plastic or paper cover and taped.

7. The electrician should then secure both exhaust and supply ventilation. Vent openings should be covered with plastic.

8. Seal cracks, as well as doors which will not be used during the treatment phase, with masking tape.

9. Post warning signs on all entrances to spaces under treatment.

10. Apply a residual barrier of insecticide around all possible exits of the area to be aerosoled to reduce or eliminate any emigration of cockroaches from the treated area.

b. *Application.* The actual treatment is to be accomplished only by certified pest control operators.

c. *Exposure time.* The air tight integrity must be maintained for at least one and preferably two hours. Treated areas should be vented for 30 minutes prior to re-entry.

d. *Post treatment cleanup.* Immediately following ventilation, all roaches and egg capsules should be collected and removed. This will serve to remove those cockroaches receiving sublethal dosages, and more important, the egg capsules which are frequently dropped by the female while attempting to escape treatment.

e. *Safety precautions for aerosol treatments.* All pilot lights and other open flames must be secured before application. The operator must wear goggles, an approved respirator, gloves and coveralls.

6. *Frequency of treatment.*

a. One week after the initial residual treatment, a survey should be conducted and all active harborages retreated. If these two steps are completed properly, it should not be necessary to treat more often than twice a month, thereafter.

b. Frequency of treatment is dependent on results from continued surveys. Insecticides should be applied only when and where needed, resulting in effective control with minimal contamination of the environment.

c. Repeated control failures should be reported to the nearest military entomologist (Articles 8—4 and 8—5).

7. *Precautions.*

a. Personnel responsible for pest control operations must be thoroughly familiar with the precautions and restrictions outlined in Section IV of this chapter and with NAVFAC MO-310 and the applicable NAVMEDCOM and/or OPNAV instructions.

(e) Surveys. The importance of conducting cockroach surveys during routine sanitary inspections cannot be over emphasized. Early detection of new or resurgent populations is essential for effective control efforts. The following points pertain to cockroach surveys:

1. Surveys should be performed by a PMT or other qualified personnel. The results from each inspection should be reported in writing to the commanding officer.

2. Since cockroaches avoid light, they are often overlooked in routine daytime sanitation surveys. Some considerations which are helpful in detecting resting sites and harborages are:

a. Pyrethrum, d-phenothrin and other pyrethroid aerosols will drive cockroaches from their hiding places within a few minutes. The spray should be directed into all cracks and crevices, breaks in insulation and pipe lagging, overhead wiring, deck drains, motor compartments of machinery, and metal supports under counters and tables. Treatment should also include areas behind splash-boards and shields, false bulkheads, pictures and bulletin boards. In many cases hard-to-eliminate infestations are due to cockroaches from an undetected breeding source, such as within walls or double floors. Do not over-spray such areas because this may cause the cockroaches to migrate to new areas.

b. A flashlight is necessary for surveying dark or dimly lit areas. Look for excreta around cracks and likely hiding places.

c. While inspecting, keep in mind the cockroach's requirement of food, warmth and moisture.

d. It is necessary to stoop and crawl to conduct a good cockroach survey.

e. Inadequate control programs aboard ship and elsewhere are invariably due in part to either a lack of or improperly conducted surveys.

(f) *Supplies and Equipment.*

Equipment required for operation and maintenance of a proper and safe cockroach control program includes the following items:

a. One gallon, hand compressed air sprayer.
b. Spare parts for the sprayer.
c. Approved respirator and refill cartridges.
d. Neoprene or nitrile gloves.
e. Goggles.
f. Coveralls.
g. Flashlight.
h. Pouring spout and funnel.
i. Tools (screwdriver, wrenches, and pliers).

(g) *Nonstandard Methods and Materials.* Fumigation of surface vessels and contracts for pest control services from commercial firms are not recommended and shall be done only on approval by the area entomologist. OPNAVINST 6250.4 provides that all locally procured pesticides and equipment must be technically reviewed and approved before procurement. Fleet units can obtain such approval from Navy entomologists stationed at any EPMU, DVECC, or from a NAVFAC Field Division Applied Biologist (Articles 8—4 and 8—5). OPNAVINST 7303.4F prohibits the use of medical department funds for pest control items. Consult NAVMEDCOMINST 6250.13 and NAVSUP PUB No. 485 for the correct procedures in procurement of pesticides and equipment to be used aboard ships.

(5) *Cockroach and control in naval hospitals and child care centers.* Cockroach control should be an integral

part of a hospital pest prevention and control program. Cockroaches are only one of the many economically important vectors and pests which justify a concerted, organized pest prevention and control program. The cumulative losses, damage, spoilage, and detrimental effects on health and welfare caused by pests and vectors represent a significant liability for the average naval hospital or activity and justifies the expenditure of funds for control. Special consideration should be given to the following

(a) Fumigation with gasses and vapors is not suitable for hospital cockroach control since it is temporary and costly, and may inhibit the medical mission.

(b) As a general rule, insecticides shall not be used in infant nurseries, operating rooms, pediatric wards, intensive care units, coronary care units, or other spaces where critically ill or debilitated patients are confined. Areas of this type should be kept free of insects by proper sanitation and construction. When insecticide treatment becomes necessary in such areas, temporary quarters shall be found for patients during the application and for a minimum of 4 hours after treatment to avoid solvent vapors. Only synergized pyrethrin and pyrethroid aerosols are currently recommended because they leave no residue, but will give immediate kill of all life stages except eggs. This treatment will not provide long-lasting control and frequent reapplications may be necessary. However, if a concentrated sanitary effort is combined with the use of residuals in surrounding rooms, effective control should result. The appropriate area entomologist can supply additional information regarding this type of control.

(c) Combat 'M is a bait station which can be used for cockroach control in hospitals and child care centers. The bait is odorless and nonvolatile, and does not produce air contamination. It is contained in a tamper-proof bait station which prevents exposure or accidental contact. It is low in toxicity to humans and safe for use around sensitive electronic equipment.

&39. Stored Products Pests, Shipboard and Ashore

(1) *General.* Stored products pests include more than 100 different species of insects, most of which are moths and beetles. They infest a wide variety of subsistence supplies including cereals, flour, farina, grits, candy, pet food, and any other non-canned food plus various animal fiber items, e.g., blankets, uniforms and boots. Stored product pests are usually either rodents (see 8—44) or insects. These stored products insects (SPI) include the saw-toothed grain beetle, flour beetles, warehouse beetle *(Trogoderma),* Indian Meal moth and many others.

(2) *Important references.* MILSTD 904A (Guidelines for Detection, Evaluation, and Prevention of Pest Infestation of Subsistence), DOD 4145.19-R-1 (Storage and Materials Handling Manual), NAVSUP 4355.4 series (Medical Services, Veterinary Food Inspection), NAVSUPPUB 486 (Receipt and Inspection Section), and the Navywide Shipboard Pest Control Manual are important references concerning stored products pests.

(3) *Detection of SPI.*

e(a) Finding infestations in storerooms is a tedious operation unless the insect populations are large enough to render the product unfit for human consumption (1-7 insects per pound depending upon the species) and spreading to other food products. Food items at highest risk include farina, grits, pet food, and any food that has been packed for at least 6 months.

(b) It is essential that ingestible products be checked upon receipt plus those near or past the Inspection Test Date (shelf life) must be checked *monthly to* find the insects before they destroy the product and contaminate other products on the ship or in the storage facility.

(c) Inspection Responsibilities. Facility, vehicle, and product inspections ashore are conducted by Army veterinary food inspectors. Aboard ship, the MDR is authorized and should conduct product (Class 9) inspections as per NAVSUP 4355.4 series while the ship is not in port to extend shelf life as appropriate. PMT's may be encouraged in the future to conduct these inspections aboard their own ships even when the ship is in port.

(d) Pheromone and Food Attractant Traps. Pheromones are chemicals secreted by an organism which cause a specific reaction by the other members of the same species. Because the pheromones are so specific, an entomologist needs to be consulted to determine if these traps are appropriate for a particular area and which traps should be used. Some of the traps for crawling insects also have a food attractant in them.

(4) *Reporting Responsibilities.* All infestations must be reported. Check the directive to determine if medical has the responsibility for your command and the appropriate reporting channel.

(a) DD 2392, Loss Due to Pest Infestation, should be submitted for each infestation. Requirements for completing and submitting the form are found in MILSTD 904A.

(b) DD 1222, Request for and Results of Tests, must be submitted to the nearest entomologist along with the insects to correctly identify the infesting insects and to document the occurence of a product infestation. Submission of this report aboard ship is the medical department's responsibility. Further requirements and explanation of DD 1222 are found in MILSTD 904A.

(c) Suspected Hazardous Food Item message is required in addition to submitting a DD 1222 when insects are found in food. Directions on proper submission are found in NAVSUPPUB 486, Chapter 4.

(5) *Sanitation.* All broken containers, tom sacks and spilled foodstuffs should be removed promptly; decks should be swept and vacuumed before receipt of new stores.

(a) Infested items must be isolated or promptly disposed of to prevent contamination of other materials.

(b) Spilled food is an open invitation to insects and rodents and it is the responsibility of inspectors to document every sanitation problem and for management to correct the deficiency.

(6) *Insect Control.* Contact the area entomologist to determine if space treatment and/or residual pesticide

application is appropriate for the particular storage area. As a general rule, spraying ship storerooms can slow down the spread of infestations to other products. Once a product is infested but still consumable, freezing it for two weeks will kill most, if not all, of the insects, while fumigating the product off the ship for at least 3 days will kill all insects in the product.

8-40. Mites

(1) *Relationship to man.* Based upon their habitats, mites of medical importance may be classified into four groups: Nest-inhabiting mites parasitic on birds and rodents, and which occasionally bite man; mites parasitic on animals and which occasionally bite man; mites parasitic on man; and food-infesting mites which occasionally bite man.

(a) *Nest inhabiting mites.* All of these mites live within the nests of birds and rodents and only bite man when deprived of their normal hosts. Medically, the house mouse mite is the most important member of this group, since it vectors rickettsial pox from mouse to man.

(b) *Mites parasitic on birds and rodents. These* mites are parasitic on rodents, birds and reptiles, and the larvae may occasionally bite man. The term "chigger" is applied to the larvae of certain species of this group. Many of these species cause dermatitis to man, and a few transmit scrub typhus (Tsutsugamushi disease), a severe and debilitating rickettsial disease of man endemic to some land areas of the Far East.

(c) *Mites parasitic on man.* This group includes the well known scabies or itch mite. The scabies mite is transmitted through close body contact and may appear wherever social conditions cause excessive crowding of people. This mite burrows in the horny layer of the dermis, causing an intense itching, especially at night, and occasionally erythema.

(d) *Food-infesting mites.* Many species of mites infest dry foods (e.g. bread, cheese, cereals and smoked meats). Some of them can also cause a contact dermatitis to workers handling infested materials. These mites also have been associated with respiratory complications (e.g. asthma exacerbation or bronchial inflammation) when they or their by-product antigens are inhaled. There are also reports of urinary tract infestations that cause irritation, urethral stricture, and a predisposition to secondary infection. Ingestion of mite infested food may lead to gastrointestinal disturbances.

(2) *Biological characteristics.* Mites can be recognized by the fact that they lack distinct body segmentation. They are usually very small, some being less than 0.5 microns (1/2000 of an inch) long. After hatching from the eggs, mites pass through three developmental stages: larva, nymph and adult. The larva has six legs while the nymph and adult forms have eight. In the species that transmit scrub typhus, the larval forms are parasitic on rodents, and incidentally parasitic on man. These larvae are quite small and usually red or pinkish in color. They feed on lymph and serous fluids and epidermal tissues which are partially predigested by secretion of salivary fluids into the host's skin during feeding. The nymph and adult stages of these mites are free-living and feed on eggs of small insects and related invertebrates. The adult females oviposit on the ground. The larval chiggers are found most often in damp areas covered with vegetation such as margins of lakes or streams, shaded woods and high grass or weeds.

(3) *Control.*

(a) *Nest-inhabiting mites.* Elimination of the house mouse mite and other important species of this group is principally dependent on host control. It may be necessary, in the case of infested structures, to apply residual sprays in the manner recommended for the interior control of flies and mosquitoes. If the structure is regularly inhabited by man, the application of residual insecticide should be restricted to infested areas only.

(b) *Mites parasitic on birds and rodents. The* chiggers of these mites are of primary importance to man. Most are not disease vectors, but may be extremely pestiferous.

1. *Protective measures.* Personnel operating in an endemic scrub typhus area where chiggers constitute a health hazard should be required to use repellents and repellent-impregnated clothing (Article 8—47).

2. *Control measures*

a. *Clearance of vegetation.* Locations which are to be used as camp sites should be prepared as fully as possible before the arrival of occupying units. All vegetation should be cut or bulldozed to ground level and burned or hauled away. Chiggers customarily live only in damp shaded soil; therefore, procedures which expose the ground to the drying effect of sunlight will help to eliminate them. After a thorough clearing, the ground usually dries sufficiently in 2–3 weeks to kill the mites. Personnel engaged in clearing operations must use protective measures.

b. *Use of insecticides.* When troops must live or maneuver for periods of time in chigger infested areas, it is recommended that area control with residual application of insecticides be accomplished. The effectiveness of any residual insecticides will vary with both the species of chigger and the area involved. Consequently, for adequate results, experimentation with materials and application rates may be necessary. Application can be achieved by using sprays, emulsifiable concentrates, wettable powders or dust. With sprays, the amount of water needed as a diluent will vary, depending on the per-minute output of the equipment used and on the kind and density of vegetation present. It takes approximately 50–100 1 per hectare (7.5–10.5 gallons per acre) of diluted spray to treat turf or similar areas and approximately 2001 per hectare (21 gallons per acre) for thorough treatment of heavy vegetated areas.

c. *Mites parasitic on man.* Control measures for scabies or itch mites should be supervised, when practical, by a medical officer. Control consists of treating infested individuals with a 1.O% gamma isomer of BHC (Lindane) and heat sterilization of clothing and bedding.

d. *Food-infesting mites.* Control of these mites is achieved by disposing of infested materials, san-

itation of food storage and handling areas and the use of effective residual sprays.

8-41. Ticks

(1) *Relation to man.* Ticks are annoying pests because of their bite and their ability to precipitate tick paralysis, but their greatest importance is related to the diseases they are known to transmit to man and animals. Some of the organisms causing disease include bacteria (tularemia, Q fever and endemic relapsing fever), rickettsia (Rocky Mountain spotted fever, Lyme disease and tick borne typhus), viruses (Colorado tick fever, Russian Spring-Summer encephalomyelitis and Louping ill) and protozoa (babesiosis and anaplasmosis).

(2) *Biological characteristics.* There are four stages in the development of a tick: egg, larva, nymph and adult. The eggs are laid on the ground, in cracks and crevices of houses, or in nests and burrows of animals. They may be laid in one large batch or in smaller groups. The period of incubation varies from 2 weeks to several months. The larval stage, identifiable by the presence of six legs, are very small upon emergence from the egg. Usually the larva requires at least one blood meal before it develops into the eight legged nymphal stage. All nymphs require at least one blood meal and one or more molts of the exoskeleton before the nymph undergoes metamorphosis to the adult stage. Some adult ticks require a blood meal before copulation while others do not. The two principle types of ticks are hard and soft ticks. The hard ticks, which include the genera *Amblyomma, Boophilus, Dermacentor, Ixodes, Rhipicephalus* and others are identifiable by their distinct hard dorsal covering, the scutum. They attach themselves to the host during feeding and remain there for a considerable period of time before engorgement is completed. The larva and nymph take only one blood meal each. The adult female takes a single blood meal before dropping off the host to digest the blood and lay a single large batch of eggs. Most hard ticks have either two or three hosts during their development. The soft ticks have four genera, *Antricola, Argus, Ornithodoros* and *Otobius,* and lack a scutum. These ticks have much the same habits as bedbugs, hiding in cracks or crevices in houses or in nests of their hosts and coming out at night to feed on the blood of the host for a short period. The larvae and nymphs generally feed several times before molting. The adult female feeds a number of times, laying a small batch of eggs after each feeding.

(3) *Control.*

(a) *Protective measures*

1. Avoid infested areas whenever possible.

2. Wear protective clothing. High-top shoes, boots, leggings or socks pulled up over the trouser cuffs help prevent ticks from crawling onto the legs and body. At the end of the day, or more often, the body should be thoroughly inspected for attached ticks, making sure that none have migrated from infested to fresh clothing or bedding.

3. Personal application of the standard issue insect repellent is effective against immature ticks and to a lesser extent the adults., The repellent is applied by drawing the mouth of the inverted bottle along the inside and outside of clothing openings. Treatments with 60 cc (2 fl oz) of repellent per man per treatment has proved effective for 3–5 days. Impregnation of clothing with repellent as described for mites (Article 8—47) is the method of choice for the protection of troops operating in tick infested areas.

4. All ticks found on the body should be removed at once. The best method for removing attached ticks is to grasp them with forceps and pull them slow steady. Do not twist! Care should be taken not to crush the tick or to break off the embedded mouthparts which could be a source of infection. The wound should be treated with an antiseptic. Where hair is not involved, the use of tape is an effective means for removing tick larvae and nymphs from the skin.

(b) *Control measures*

1. *Clearance of vegetation.* Clearing vegetation from infested areas will aid in the control of ticks and is recommended for bivouac and training grounds. All low vegetation should be uprooted with a bulldozer and burned or cut and hauled away.

2. *Use of insecticide*

a. *Outdoors.* In situations where troops must live or maneuver for periods of time in tick infested zones, area control by residual application of sprays, dusts or granules should be achieved. The effectiveness of any insecticide will vary with both the species and the area involved. Experimentation with various dosages and materials may be required. Sprays should be made by mixing either an emulsifiable concentrate or a wettable powder and water. Oil solutions should be avoided because they cause plant damage. The amount of spray mixed will depend on the volume output of the equipment used and on the kind and density of vegetation to be sprayed. It takes approximately 1901 per hectare (20 gal per acre) of spray to treat lawns or similar areas, and 4751 per hectare (50 gal per acre) or more for thorough coverage of wooded or brushy areas. Vegetation should be sprayed at a height of 0.6 m (2 ft). Application rates for dusts will vary from approximately 2–5 kg per hectare (2–5 lb per acre), depending upon the insecticide and terrain. Insecticides should be applied as early in the year as ticks are noticed. One application may be effective for an entire season, but if ticks reinfest the area it may be necessary to repeat treatment.

b. *Indoors.* The brown dog tick, *Rhipicephalus sanguineus,* frequently becomes established in dwellings and is difficult to control. A residual emulsion spray is the treatment of choice in this situation. Apply spray thoroughly to all possible harborages, including baseboards, around door and window moldings, behind pictures, under furniture, around the edges of rugs, on curtain and draperies and in all cracks. A second or third treatment may also be needed. Residual treatments in living spaces are to be made in infested areas only. This tick is usually introduced into living spaces by dogs; so control procedures should also include a thorough residual spraying of the spaces occupied by the dog at

night, and a weekly treatment of the dog as directed by a veterinarian.

8-42. Fleas

(1) *Relation to man.* Like most other blood-sucking parasites, fleas have been implicated in the transmission of diseases. The oriental rat flea, *Xenopsylla cheopis,* is of great importance in the transmission of the plague bacillus which alone is sufficient to rank fleas among the more important insect vectors. Other genera of fleas transmit endemic or murine typhus and may act as the intermediate hosts for some parasitic worms. Gravid females of the "chigoe" or burrowing flea, *Tunga penetrans,* penetrate the skin to complete their development, causing ulcerating lesions on the feet of man and of animals. Fleas found outdoors are frequently referred to as "sand fleas"; however, they do not breed in the sand without animal hosts.

(2) *Biological characteristics.* Fleas are ectoparasites of birds and mammals. They are small, laterally compressed, hard-bodied insects that lack wings, but are equipped with legs especially adapted for jumping. The nest or burrow of the host is the breeding place and contains the egg, larva, pupa and frequently the adult flea. The eggs are oval, pearly white and dropped randomly on the ground, floor or animal bedding where they hatch into larvae in a few days. Flea larvae are tiny, cylindrical, and maggot-like with neither legs or eyes. They feed on organic matter and grow for about 2 weeks. When they are ready to pupate, the larvae spin silken cocoons which are somewhat viscid so that particles of dust, sand and lint stick to them. Most fleas do not remain on their host continuously. Unlike most blood-sucking insects, fleas feed at frequent intervals, usually once a day. This is because fleas are easily disturbed while feeding and seldom complete a meal at one feeding. The "chigoe" flea is exceptional in that the fertilized female burrows into the skin of its host, particularly between the toes, under the toenails, and in the tender part of the feet. Here, nourished by the host's blood, the eggs within the female develop and the abdomen swells to almost the size of a pea. The posterior end of the flea lies level with the surface of the host's skin. The mature eggs are expelled through the ovipositor at the tip of the abdomen. The female then shrivels up and drops out or is sloughed during tissue ulceration.

(3) *Control.*

(a) *Protective measures*

1. Avoid infested areas when possible.

2. Wear protective clothing or at least roll the socks up over the trouser cuffs to prevent fleas from jumping on the skin.

3. Personal application of standard issue insect repellent is effective for short periods (Article 8—47).

(b) *Treatment of breeding areas.*

1. In infested buildings, apply residual sprays as emulsions or suspensions on floors, rugs and on wall surfaces to a height of about 0.6 m (2 ft) above the floor.

2. Flea infested areas such as yards and under buildings should be treated" with a residual emulsion. To prevent entries into structures, spray the foundation to a height of 0.6-0.9 m (2–3 ft). Vegetation should also be treated to a distance 1.5 m (5 ft) from the base of the foundation.

3. When flea-borne diseases are present, rat burrows should be dusted with an insecticide prior to conducting rodent control measures. This prevents fleas from leaving dead or trapped rats and migrating to other animals or human hosts in the area.

(c) *Treatment of infested animals.* Because indoor flea infestations normally originate from pets, a program for controlling such infestations must include treatments of these pets. Dogs and cats are best treated with dusts and hand held aerosols under the direction of a veterinarian. Bedding used by pets should be simultaneously treated.

8-43. Reduviid Bugs

(1) *Relation to man.* Reduviid or cone-nose bugs of several genera, *Panstrongylus, Rhodnius* and *Triatoma,* are important to man as vectors of the protozoan parasite, *Trypanosoma cruzi,* which causes Chagas' disease or American Trypanosomiasis. These insects occur in South and Central America, Mexico and in the Southwestern United States. The infected insect bites man, defecates during feeding or soon afterward, and the infected feces is introduced into the bite by scratching or rubbing. Infection can also take place through contamination of the conjunctival, mucous membranes, wounds or scratches.

(2) *Biological characteristics.* Human biting reduviid bugs are nocturnal, blood-sucking insects that are about 13–19 mm (½-¾ in.) in length. The anterior half of the wing is leathery and the posterior half membranous; the head is cone-shaped with a proboscis divided into three sections which are folded under between the front legs; and the abdomen is flared out and upward to form a depression for wings. Stages of the life cycle consists of an egg, nymph and adult. The nymphs are similar to the adults except for being smaller and having underdeveloped or partially developed wings. The eggs are barrel-shaped and are deposited in dusty comers of houses or in nests and burrows of animal hosts. The young nymphs hatch from the eggs, obtain blood meals from their hosts and shed their skins, developing into larger nymphs in the process. This is repeated through five nymphal stages to the adult stage. The entire life cycle requires 1–2 years. Normal hosts of these insects includes rodents, bats, armadillos and sloths. To man their bite is usually painless and will not disturb a sleeping person. There is usually no reaction to the bite, but in some cases bitten individuals have experienced symptoms of dizziness, nausea and intense itching on various parts of the body.

(3) *Control.* Destruction of reduviid bugs is difficult. Their invasions can be prevented by screening and otherwise making dwellings insect proof. Nests of wood rats and other host animals should be eliminated in the general area of dwellings, particularly under structures. For

chemical control, suspensions or emulsions should be used as a residual treatment on the interior walls and floors. Shelters or huts with palm thatched roofs should be avoided as bivouac areas.

8-44. Rodents, Shipboard and Ashore

(1) *General.* Rodents, have associated with man for ages. Several species are particularly well suited for specialized conditions found both aboard ship and ashore. The distribution of rodents is worldwide; consequently, the problem of control presents itself during operations in any geographical location.

(2) *Relation to man.* Rodents such as rats, mice and ground squirrels may serve as reservoirs for plague, endemic typhus, tularemia and other debilitating diseases. The problem of contamination of supplies and direct property damage by rodents may also be considered.

(3) *Important species. The* semi-wild forms, which live in the jungles, forests and wastelands, have little or no contact with man and are relatively unimportant in rodent control. However, military operations and occupation may change this situation. The most important rodents from the medical and economical viewpoint are:

(a) *Norway rat.* The Norway, brown or gray rat, *Rattus norvegicus,* is a comparatively large animal, weighing approximately 280-480 gm (10–17 oz), with a tail that does not exceed the combined length of head and body. This rat is present wherever human activity creates suitable harborages and there is an adequate food supply. It prefers to burrow for nesting and is mainly found in basements, embankments, on lower floors of buildings, in drains and sewer lines and in the holds and decks of ships. Preferred foods include meat, fish or flesh mixed with a diet of grains, vegetables and fruit. In the absence of these, any foodstuffs may be eaten.

(b) *Roof rat.* The gray bellied, Alexandria or roof rat, *Rattus rattus alexandrines,* is a good climber and may be found living in trees, vines, building lofts, overhead wiring and upper decks of ships. The body is generally elongated, the ears are long and the tail exceeds the combined length of the head and body. There are many color and body type variations. The black or ship rat, *Rattus rattus rattus,* a subspecies variant of the roof rat, *R. r. alexandrines,* is an excellent climber and is frequently found on ships. These rats prefer seeds, cereals, vegetables, fruit and grass, but may subsist on leather goods, chocolate and even weaker members of its own kind.

(c) *House mouse.* The house mouse, *Mus musculus,* is commonly associated with man and may cause serious damage to foodstuffs and other valuable materials. Various species of field mice may on occasion enter habitations in search of food and shelter, but they do not present a major problem.

(4) *Control and prevention of rodents ashore.* Rodent control programs should include elimination of food and shelter, rodent proofing of structures, and use of single dose anticoagulant bait stations, glue boards and snap traps.

(a) *Elimination of food and shelter.* Proper handling of food and prompt disposal of garbage keeps food from being available and is important in rodent control programs. Food storage structures should be completely rodent proofed. All supplies should be stockpiled on elevated platforms so that no concealed spaces exist. Garbage should be put in tightly covered containers which should be placed on concrete slabs or platforms and the area should be frequently and carefully policed. If wet garbage must be placed in landfills, the refuse should be completely covered to prevent its use as a feeding source for rodents.

(b) *Rodent proofing.* Rodent proofing is not generally feasable for troops in the field. However, where structures are built, all necessary openings should be covered with 28 gauge 95 mm (3/8 in) mesh galvanized hardware cloth, doors should be self-closing, tight fitting, and if giving access to galleys and food storage rooms, equipped with metal flashing along the base. Walls and foundation should be of solid construction.

(c) *Ectoparasite control.* Prior to initiation of an active rodent control program, particularly when a disease risk exists, control of ectoparasites should precede rodent control.

(d) *Rodent Control Methods.*

1. *Poisoning.* For destruction of rodents in camp areas, the use of rodenticides combined with bait materials is the method of choice. Because most rodenticides are toxic to man and domestic animals, they should be used only by appropriately trained personnel. Anticoagulant compounds are the rodenticides of choice under most conditions. The hazard to persons and pets with properly used anticoagulant rodenticides is less than that of traps.

a. *Single Dose Anticoagulant rodentitides.* These materials prevent blood clotting and cause capillary damage which leads in most cases to internal hemorrhage induced death. At concentrations recommended for rodent control, most anticoagulant agents are not detectable or objectionable to rodents. Brodifacoum and bromadiolone are two examples of single dose anticoagulants.

1. Adequate exposure to anticoagulant baits is contingent on the establishment of a sufficient number of protected bait stations. This can be accomplished by placing tamper proof bait boxes in rooms or areas where there is a potential for rodent activity. Every container of poisoned bait should be labeled POISON with red paint in English and in the local language if in a non-English speaking area.

2. The frequency of bait station inspections and size of bait placements and replenishment depend upon the degree of infestation encountered. The length of time required for rodent control will vary from 1 week to months depending upon the availability of food supplies and other factors.

3. Baits should be kept dry during use in order to maintain maximum acceptability and toxicity. Where premises are particularly vulnerable to reinvasion, it is often practical to maintain tamper proof bait stations after control has been attained.

4. Where rodent infestations occur, the use of poisoned bait, glue boards and traps is recommended to obtain quick initial control. When traps are no longer useful, they should be removed but the baiting continued. This is appropriate especially in buildings where food is stored, prepared or served, unless it is determined that the building is not vulnerable to reinvasion. Any reinvasion is evidenced by a low level of bait consumption. Maintenance of control is almost automatic as long as sufficient good bait is maintained.

5. In tropical and semitropical areas where rodent infestation is commonplace and not confined to buildings, area as well as building control must be used. Basically, the same exposure technique should be used in employing baits for mouse control as is outlined for rat control. The main difference is that a larger number of bait placement should be made in areas where the mice are known to feed. Feeding stations in some cases only consist of one tablespoon of bait at 2-4 m intervals.

b. Consult the area entomologist to determine if there is an appropriate liquid rodenticide.

2. *Glue boards.* These have shown to be effective in markedly reducing mice infestations (and probably rats) within 2–3 weeks when placed properly in the area of rodent activity. Placement should be the same as for rodent snap traps. A small amount of peanut butter in the center of the board increases the attractiveness.

3. *Trapping.* It is frequently necessary and desirable to supplement glue boards with traps. The use of traps requires skill and persistence. The wood-base spring trap is the most effective type and should be used in adequate numbers.

a. Rodents, being creatures of habit, will frequently avoid the traps as new items in the environment. Tests show that within 2–3 days, these traps are accepted as part of the environment. This is when the traps should be set to spring-not before. The catch is usually excellent the first night.

b. Traps should be tied to overhead pipes, beams or wires, nailed to rafters or otherwise secured wherever black greasy marks indicate runways.

c. On the ground, rodents normally run close to the walls. Consequently, the traps should be set at right angles to the rodent runways with the trigger pans toward the bulkhead. Boxes and crates should be positioned to create passageways where the rodents must pass over the traps. They also should be placed so as not to be visible from the passageway entrance.

d. Although unbaited traps with the trigger pan enlarged with a piece of cardboard or lightweight metal may be used in narrow runways, trapping is usually more effective when accomplished with baited triggers. Preferred trap baits vary with the area and species of rodent involved, and include bacon rind, nuts, fresh coconut, peanut butter, raw vegetables, and bread or oatmeal dipped in bacon grease.

e. Service all traps regularly to remove rodents and replace the bait.

f. For infestations not controlled by trapping, contact a Navy entomologist or applied biologist.

4. *Fumigation.* Fumigation will effectively destroy rodent populations in their burrows and other hiding places. Where the fumigation can be confined, this method of control will also kill ectoparasites infesting the rodents. Fumigation for rodent control using hydrogen phosphide or other products should be conducted only by appropriately trained personnel.

(5) *Control of rodents aboard ship.*

(a) *Prevention of entry.*

1. *Utilization of rat guards.* Foreign quarantine regulations require that rat guards be used by naval vessels when berthing in ports where plague is endemic to prevent introduction of rodents on the ship. Rat guards should be a minimum of 36 in diameter and mounted at least 6 feet from the closest point on shore or ship. After a ship leaves a plague infested port, rat guards should be used at other foreign ports-of-call enroute to the United States. Rat guards are recommended at all foreign ports-of-call and in United States Ports. Specific Atlantic and Pacific Fleet instructions apply. CINCLANTFLTINST 5400.2 series and CINCPACFLTINST 5440.3 series cover rat guard use.

2. *Illumination and movement restrictions.* Rodents are basically nocturnal. Therefore, gangways and landing ramps shall be well lighted at night to discourage rodent movement aboard. Gangways and other means of access to the vessel shall be separated from the shore by at least 1.8 m (6 ft) unless guarded to prevent rodent movement. Cargo nets are similar devices extending between the vessel and shore must be raised or removed when not in actual use.

3. *Pierside inspections.* Inspections of all subsistence items and cargo for rodent signs, such as droppings, hair, gnawing or live rodents are essential in attempting to maintain a rodent free ship.

(b) *Sanitation.* The elimination of food and shelter through proper handling of food and prompt disposal of garbage and rubbish will reduce the attractiveness of the ship to rodents.

(c) *Rodent control.*

1. Glue *boards and trapping.* Because of the odor from dead rats in confined spaces of a ship, glue boards are the method of choice for small infestations. Basically, the method on ships is the same as that ashore (for details, see (4)(c)2. and (4)(c)3. of this section). On the deck, glue boards or traps should be set behind objects that are stacked close to a bulkhead, along rows of boxes and between crates and barrels forming runways. The traps should be set at right angles with the trigger end toward the bulkhead. They should be tied or nailed down to prevent an injured rodent from crawling off. All trap baits should be wrapped in 5 cm (2 in) gauze squares before attachment to the trigger to prevent removal of the bait without springing the trap.

(d) *Deratization certification.* A certificat e of Deratization (rat free) or a Deratization Exemption Certificate is required for naval vessels entering most foreign ports. Requirements for this certification are detailed in NAVMEDCOMINST 6250.7 series.

8-45. Insect Control on Submarines

(1) *General.* The exclusion and sanitation measures detailed for insect control on surface vessels applies for submarines. However, eradication of an established infestation presents a special problem because repeated residual treatments with insecticides may produce undesirable air contamination.

(2) *Residual insecticides.* In most cases, the use of residual insecticides is the method of choice for insect control in submarines. However, residual insecticide application is authorized only when in port and when outboard ventilation for a minimum 24 hours is possible. Residual insecticides authorized for use on submarines are:

(a) Propoxur, NSN 6840-01-127-3865, is a 13.9% emulsifiable concentrate, is used to formulate a 1% emulsion. Technical approval must be obtained from the appropriate medical or area entomologist prior to purchase.

(b) Combat™, NSN 6840-01-180-0167, is a bait station which can be used for cockroach control aboard submarines while underway. The bait is odorless and nonvolatile, and does not produce air contamination. It is contained in a tamper-proof bait station which prevents exposure or accidental contact. It is low in toxicity to humans and safe for use around sensitive electronic equipment.

(c) Dursban™, NSN 6840-01-210-3392, in 40 ml bottles. This premeasured bottle of concentrate is mixed with one gallon of water to give a one-half percent solution of Dursban.

(d) Synthetic pyrethroid (2.0% d-Phenothrin), NSN 6840-01-067-6674 is a low pressure aerosol in a hand held, non-refillable container. This material causes a "flushing" action with cockroaches. It is useful in determining the extent of cockroach infestations and provides residual action.

(3) *Fumigation.* Fumigation will not be attempted without NAVMEDCOM approval. The need for fumigation should be established in each case by an entomologist prior to requesting NAVMEDCOM approval. The applicable fumigant, carboxide gas, would be recommended only when control could not be obtained using the previously mentioned insecticides and methods.

(4) The following instructions regarding use of insecticides, except Combat™, onboard submarines must be followed:

(a) They must be used only when the boat is in port and is not expected to submerge for a period of 24 hours after application.

(b) The boat's exhaust air must either be discharged overboard or used by the engines for a period of 24 hours following application.

(c) Insecticides and equipment must NOT be transported or stored on submarines, with the exception of Combat™ bait stations (up to 144 stations may be onboard). The respective submarine tenders maintain a supply of insecticide and insecticide dispersal equipment.

(d) Extensive areas must not be covered with residual insecticides. The method of application of liquid residuals is the same as for surface vessels.

(e) Personnel responsible for mixing, application and storage of the materials must be certified pest control operators or vector control specialists. They must be familiar with the precautions outlined in the applicable NAVMEDCOMINST 6250 series.

(f) Ready to use solutions of oil based Baygon™ or diazinon may not be used.

8-46. Common Venomous Arthropods

(1) *General.* Injury produced by venomous arthropods is more common than generally realized. Millions of people in the United States are affected by these arthropods each year. About 25,000 of these envenomizations result in severe injury and about 30 result in death. This mortality contrasts markedly to the usual 14 deaths per year that are caused by poisonous reptiles. Clinical manifestations associated with envenomization include anaphylactic shock, hemolysis, necrosis, paralysis, cardiopulmonary dysfunction, allergenic asthma, and antigen induced dermatologic manifestations.

(2) *Venoms.* Venoms produced by arthropods are mixtures of four toxic types: Vesicating (blister beetles), neurotoxic (black widow spiders), cytolytic (brown recluse spider), and hemolytic (horse flies).

(3) *Venomous arthropods of importance*

(a) *Centipedes.* Centipedes are fast moving, dorsoventrally flat, elongate arthropods having one pair of legs per body segment. All centipedes contain venom producing glands that are connected by tubes to claws, that are modified appendages on the first body segment. The potential for these arthropods to inflict injury on man is contingent on the size of the claw and its ability to penetrate the skin. Injected venom causes a considerable amount of pain, but rarely death. When death occurs, it is believed to be a result of an anaphylactic reaction. The wound should be disinfected and a medical officer consulted.

(b) *Millipedes.* These arthropods are slow moving, rounded, elongated arthropods with two pairs of legs per body segment. Many millipedes exude a vesicating fluid and may cause injury to persons handling them. Some are capable of squirting vesicating venom some distance and may cause severe injury to the eyes as well as the skin.

(c) *Scorpions.* Scorpions are venomous arachnids that rarely sting man, and then, only when provoked. Although few species are deadly, all stings should be considered dangerous because of the hemolytic and neurotoxic venom properties. The signs and symptoms associated with these stings vary with species and may include tachypnea, tachycardia, nausea, glycosuria, epigastric pain and tenderness, excessive salivation, slurred speech, tissue discoloration and necrosis. The ground scorpions have a predominantly hemolytic toxin which is generally associated with swelling and except in the young, old or debilitated, death is uncommon. On the other hand, the venom of bark scorpions has a dominant

neurotoxin that does not cause swelling and is more often associated with death.

(d) Spiders. Spiders are venomous arachnids and in most cases are considered to be beneficial because they feed on other arthropods. Bites of black or brown widow spiders *(Latrodectus mactans* and *Latrodectus geometricus* respectively), and the brown recluse spider, *Loxosceles reclusa,* are serious and of considerable medical importance. The venom of the *Latrodectus* spp. is strongly neurotoxic, causing severe symptoms of extreme pain, abdominal cramping, profuse perspiration, respiratory duress, and speech inhibition. Only 5% of untreated cases are fatal. The venom of *L. reclusa* is strongly hemolytic and vesicating, causing progressive tissue necrosis.

(e) Blister beetle. When these beetles are touched, they exude a drop of vesicating fluid through the membranes of the appendage joints. The active ingredient of this fluid is cantharidin. Upon dermal contact, this fluid causes formation of serious blisters which eventually break, the released fluids causing satellite blisters. Bacterial secondary infection is common. Medical attention for affected individuals is considered important.

(f) *Hymenopterous insects.* Member species of bees, wasps, yellow jackets, hornets and ants are high in number and are the most common sources of serious envenomization. The stings of these insects can be quite painful. Although the composition of hymenopteran venoms vary, most of them have a predominantly hemolytic factor associated with a smaller fraction of neurotoxin. Reactions between individuals exposed to a specific venom may vary considerably. For example, a bee sting may cause no effect or it may precipitate death. A serious manifestation of hymenopteran hypersensitivity is anaphylactic shock occasionally accompanied by regurgitation, encopresis, enuresis, rapid decrease in blood pressure, atypically slow pulse, prostration, debilitation and possibly death.

(g) *Caterpillars.* Caterpillars, the immature form of many species of Lepidoptera, may cause mild to severe contact dermatitis, nodular conjunctivitis, respiratory pain, headache and convulsions by injecting a hemolytic venom into the skin by the tiny stinging (urticating) hairs that cover their bodies. These hairs may be present on not only the caterpillars, but on the egg covers, cocoons, and adults. The hairs may become airborne after being broken off, or be present in soil after the exoskeleton has been shed or the caterpillar is killed. An association with hairs from these sources can cause pulmonary inflammation and edema and/or dermal involvement. Injury by urticating caterpillars is seasonal, usually occurs in the spring, and is most common among children playing in trees or shrubbery. The most important species of these caterpillars in the United States are the puss caterpillar, *Megalopyge opercularis;* saddleback caterpillar, *Sibine stimulea;* range caterpillar, *Hemileuca olivaiae;* crinkled flannel moth, *Lagoa crispata;* and the slug caterpillar, *Adoneta spinuloides.* Tape can be used to mechanically remove imbedded hairs or spines.

(h) *Allergens.* Insect allergens may be a significant causative factor in clinical allergic respiratory involvement, especially of the seasonal type, as shown by skin test reactions to insect extracts. Some insects associated with clinical conditions include mayflies and fungus gnats, which may cause asthma; caddisflies, which may cause asthma and coryza; and bees, which occasionally precipitate hypersensitive airborne particles. Aphids, beetles and house flies may cause allergic rhinitis or asthma. Stored food insects may be a significant factor in mite dust allergy, while household insects may be a causative factor in house dust allergy.

(4) *First aid for envenomization.* First aid for envenomization depends upon the nature of the venom, but the following general procedures are recommended:

(a) Take the victim to or contact a physician immediately. If this is not possible call a physician immediately for advice.

(b) If marked swelling or discoloration occurs at the site of envenomization, the venom is probably hemolytic, hemorrhagic or vesicating. Keep the victim warm and quiet until a physician is consulted.

(c) If little or no swelling or discoloration occur at the site of envenomization, the venom is probably neurotoxic. Apply ice to the site or, if possible immerse the affected part of the body in ice water. Do not let the measures delay getting the victim to a physician.

(d) A physician must be reached if anaphylactic shock symptoms appear. During transportation or until medical assistance arrives, treat the patient symptomatically.

(5) *Treatment of Envenomization.* Treatment of envenomization varies with the type of envenomization and the nature and severity of the symptoms. Neurotoxic envenomization is treated with specific antivenoms or with intravenously injected gluconate, epinephrine or adrenaline. Cytolytic envenomization often requires prolonged symptomatic treatment. Hemorrhagic envenomization, when severe, is treated with vitamin K. Urtication is treated by washing the skin with a bactericidal soap and a course cloth to remove any remaining hairs. Administer antihistamines. Vesicating envenomization is treated by draining the blisters with a sterile hypodermic needle, followed by application of magnesium sulfate compresses, and careful disinfection of the blisters to prevent secondary infection. Anaphylactic shock is treated by use of a tourniquet and subcutaneous injections of epinephrine. Allergic reactions are treated symptomatically with antihistaminic, adrenergic, spasmolytic and anticholinergic drugs.

(6) *Prevention of Envenomization.* Prevention of envenomization differs with the species of arthropod involved. The best technique is education, especially of children, to avoid venomous forms. The information given should be pertinent to the biology of the venomous species. For example, individuals hypersensitive to stinging Hymenopteran should wear light colored, smooth fabrics and avoid leather or suede. It is advisable to keep hair covered, avoid scented cosmetics, stand still when approached by bees, wasps, or hornets, and confine outdoor

activity as much as possible to times when temperatures are below 15.6 degrees C (60 degrees F).

(7) *Control of Venomous Arthropods.* Specific residual insecticides are recommended for control of venomous arthropods. However, control of infestations of venomous species frequently require special considerations because of their diverse nesting habits. Consequently, it is recommended that the area entomologist be consulted when control measures are, being considered.

8-47. Use of Repellents

(1) *General*

(a) *Purposes.* Most repellents act as contact materials, keeping insects from biting when they touch the protective chemical with their mouth parts or feet. Some repellents may be sufficiently volatile so that insects refrain from coming close to the treated surface. Repellents may be used as undiluted liquid concentrates or formulated as solutions, emulsions, creams, lotions, powders, solid stick forms or aerosols. Repellents offer protection from bites of mosquitoes, black flies, biting gnats, biting midges, fleas and may provide some protection against ticks and larval and adult mites. Repellents are designed primarily to repel biting insects and are not generally effective against the venomous arthropods.

(b) Protection time. The period of effectiveness of repellents varies with environmental conditions, concentration of the active ingredient, arthropod species, and activity of the treated person. Repellents are removed from the skin by absorption, evaporation, abrasion and dilution by perspiration. Consequently, the period of effectiveness is considerably reduced through strenuous activity, especially in warm humid weather. Clothing repellents may remain effective for several weeks depending on leaching due to washing, dry cleaning, rainfall, and perspiration among other factors.

(2) *Personal Application Repellents.*

(a) *Availability. Insect repellent, Personal Application, 75% Diethyltolumide,* NSN 6840-00-753-4963. *This* repellent is packaged in 59 cc (2fl oz) polyethylene bottles and contains 75% DEET by weight in 25% denatured ethyl alcohol (ETOH). It is nearly colorless, but has some odor. This material will damage lacquer, paint and some plastics.

(b) *Application of Repellents.*

1. *Liquids.* When a repellent solution is used for skin application, a small quantity (approximately 12 drops or 1/2 teaspoonful) is poured into the palm of the hand. The palms of the hands are rubbed lightly together with a washing motion and the arms are then covered by rubbing. If long sleeved shirts are worn, the repellent should be applied to the underside of the arms and under the cuff. Additional repellent is then poured into the palm and the procedure is repeated, carefully applying repellent to the exposed areas of the body. Repellents will cause a burning/drying sensation if allowed to contact mucous membranes; consequently, repellents should NOT be applied near the eyes or the lips. Continued exposure of repellents in the folds of the axilla, elbow and knee will often produce dermal irritation in hot, humid conditions. The back of the neck, ears, and the hair line should be coated carefully. It is important that if a shirt is being worn, that the repellent be especially applied to the neck under the collar and particularly low on the neck if a collar is lacking. Repellent is also applied to the socks above the shoes. Insects with piercing/sucking mouth parts (e.g., mosquitoes) will occasionally bite through tight fitting clothing having an open weave. If necessary repellent can be applied by hand to the cloth covering these tight fitting areas (e.g., shoulders, buttocks, around the elbows and on the front of the thighs). To prevent mites, ticks, and crawling insects from getting onto the body, a 1.3 cm (1/2 inch) barrier band of repellent should be made around the cuffs, waist/fly and neck by applying the mouth of the bottle directly to the cloth. Any dermal area that is not treated is subject to attack. When DEET is used, supplementary applications may be necessary every 4 to 7 hours, depending upon loss through sweating, wading in streams, contact with wet foliage, and similar activities. Personnel exposed to infestation by vector mites in scrub typhus endemic areas should routinely apply the repellent. In geographic areas where vectored diseases exist, emergency treatment of garments with DEET can be done with about 75 cc (2.5 fl oz) per person.

2. *Aerosols.* If DEET is used as an aerosol, the spray should only moisten the surface and not saturate the entire cloth. Care should be taken to spray all tight fitting areas close to the body (e.g., socks, tongues and tops of shoes, garment cuffs and neck and waistband/fly areas).

(3) *Clothing Application Repellents.*

(a) *Materials and Methods.* The same repellent (DEET) recommended for skin application may be applied by hand or sprayer to the outer surface of the clothing, particularly across the shoulders, around the waist and seat of the trousers and on the socks. On clothing, repellents retain effectiveness for longer periods than on the skin, unless the clothing becomes wet from rain, wading through streams, or other water exposures which may cause the repellent to leach out. This is especially true with DEET which otherwise is very effective when applied to clothing.

Section VII. DISINFECTION OF NAVAL VESSELS AND AIRCRAFT CARRYING QUARANTINABLE PESTS

8-48. General

Disinfection (elimination of insects) on vessels and aircraft is defined in SECNAVINST 6210.2 series and encompasses procedures to prevent the transfer of live disease vectors from infested to noninfested areas. Disinfection should always be accomplished on leaving ports and airports where yellow fever, malaria, or plague are endemic. Public Health disinfection requirements are determined by the World Health Organization (WHO) and the Center for Disease Control (CDC) of the PHS. Commanding Officers should be aware of and comply with all applicable domestic and foreign quarantine regulations.

8-49. Disinfection of Vessels

Disinfection of vessels is always be performed on those vessels departing foreign ports where vector-borne diseases, including yellow fever, malaria, and plague are endemic or epidemic in the immediate port area. After leaving these areas, the medical officer or the medical department representative trained in shipboard pest control procedures should make a survey to determine whether insects capable of transmitting disease are present aboard the vessel. If disease vectors are present, the commanding officer is to be notified and suitable disinfection procedures initiated. Such procedures include elimination of all standing water sources where mosquito breeding occurs, space treatments with aerosols or residual application of pesticides. Information on materials and methods for the control of disease vectors and pests aboard naval vessels is found in Section VI.

8-50. Disinfection of Aircraft

(1) *Geographic Areas Affected.* All aircraft, except that part of the cargo section treated in accordance with retrograde cargo handling procedures, operated or under the command jurisdiction of the Navy should be disinfected immediately before the last takeoff prior to entering the following areas:

(a) The United States or its possessions from a foreign port between 35 degrees north and south latitude. Aircraft landing in the United States north of 35 degrees north latitude need not be disinfected unless the aircraft precedes immediately to an area south of 35 degrees north latitude.

(b) A foreign area according to requirements of that country.

(c) The State of Hawaii, including flights originating in the continental United States.

(2) Serialize and log aircraft disinfected for official record.

(3) *Materials.* Insecticide aerosol, d-Phenothrin, NSN 6840-01-067-6674 is used to disinsect all aircraft arriving in the United States from a foreign country located within quarantine areas. Aircraft preceding from quarantine areas within the United States to a foreign country or between foreign countries should also be treated.

8-51. Methods

(1) The aerosol should be uniformly dispersed throughout the space to be treated by directing it toward the ceiling of the compartment.

(2) Baggage compartments, wheel wells and other areas where insects may find shelter on the outside of the aircraft should be sprayed after loading and boarding operations are completed and just prior to departure.

(3) On passenger carrying aircraft, cover or store all exposed food, food preparation and service areas, and cooking and eating utensils. After all passengers and crew are aboard, close all doors, windows, hatches, and ventilation openings. Spray the cabin, cockpit, and other compartments accessible from within the aircraft. The aircraft should not be opened again prior to takeoff.

(4) Where it is not feasible to carry an aerosol container on board an aircraft, the interior shall be sprayed just prior to takeoff. This applies primarily to one and two crew type aircraft.

8-52. Special Problems

If a question arises as to whether disinfection has been successful or whether a special problem of insect infestation exists that is not amenable to disinfection procedures herein recommended, a request for assistance should be made by the vessel or aircraft commander. This request should be to quarantine officials at the sea or airport upon arrival or to the area DVECC or EPMU. The PHS Foreign Quarantine Branch may require disinfection beyond those of standard directives if an unusual or emergency situation exists.

8-53. Quarantine Procedures

(1) Quarantine procedures include measures designed to prevent dissemination of disease organisms infective to plants, animals and/or man. Basic regula-

tions and detailed instructions concerning quarantine procedures are presented in SECNAVINST 6210.2 and NAVMEDCOMINST 6250.7 series.

(2) By international convention, a Certificate of Deratization or a Deratization Exemption Certificate is required of vessels entering most foreign ports if detention for fumigation is to be avoided. A valid certificate can only be issued by the PHS or its appointed representatives.

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Section VIII. PESTICIDE DISPERSAL EQUIPMENT

&54. Equipment Availability and Suitability

The requirements for pest control equipment are numerous because of the variety of organisms, their habitat, and the types of control agents that are to be dispersed. Depending on the control problem, pesticide dispersal equipment is available for meeting the needs of confined or broad areas, whether the requirements call for stationary, portable, vehicular or aerial equipment use. Because equipment types are continually being modified or developed to meet specialized or changing needs, it is essential to contact the appropriate medical entomologist or applied biologist for recommendations regarding the most appropriate equipment, as well as, its authorized use.

Section IX. COLLECTION AND PREPARATION OF SPECIMENS FOR SHIPMENT TO MEDICAL LABORATORIES

8-55. Introduction

(1) *Insects, other arthropods, and vertebrates of medical importance.* Whenever possible, specimens should be collected and identified. Specimen acquisition permits development of collections representative of all geographical areas where naval personnel are stationed. These collections then provide a reference source to determine whether, during subsequent surveys, new or existing specimens are found to have moved into or left a specific area. Also, due to geologic variations pertaining to control, the importance of accurate vector and pest species identification cannot be over-emphazied.

(2) *Data Requirements.* To ensure the scientific value of specimens, it is necessary to record all pertinent data at the time of collection. The minimum information that must accompany all specimens is the date collected, the precise location and the collector. Other important information includes method of collection, elevation, host, habitat, behavior, time of day, specimen coloration, and any significant morphological or ecological observations. All associated data should be kept with the specimens as they are moved, mounted, studied or shipped. Labels should be written with a soft lead pencil or pen and india ink, and to avoid loss or switching, placed inside vials, novocain tubes or boxes with the specimens. With pinned specimens the labels should be mounted on the pins below the specimens.

8-56. Procedures

(1) *Arthropods.*

(a) *Dead specimens.* When shipping material by mail, an advance letter should be sent to the addressee notifying him of the shipment and its content. The actual shipment, via parcel post, is marked “Dried (or Preserved) Insects for Scientific Study” and “Fragile.” If the shipment is from overseas the statement “No Commercial Value” will facilitate passage through customs.

(b) *Live specimens.*

1. *Quarantine and shipping regulations.* If live arthropods or arthropods containing infectious etiologic agents are to be shipped from overseas or interstate, permits may be required by PHS and/or the U.S. Post Office. To ensure compliance with regulations, refer to SECNAVINST 6210.2 and NAVMEDCOMINST 6210.3.

(2) *Shipment.* Delicate insect larvae and adults cannot be easily shipped; therefore, the more durable eggs or pupae should be sent whenever possible. Shipments should be air mailed or sent by special delivery if necessary. Ventilate the package but make sure the insects cannot escape. Pack carefully and mark the package “LIVING INSECTS” so it will receive special handling. An advance letter should be sent to the addressee notifying him of the shipment and its content.

(a) *Unpinned specimens.*

1. *Mosquito larvae.*

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(a) *Unpinned specimens.*

1. *Mosquito larvae.*

a. Collection. Mosquito larvae are collected to determine the species involved, breeding sites and relative abundance. The tools used in collecting larvae include a long handled white enamel dipper, a large mouth pipette, a piece of rubber tubing several feet long, a suction bulb, screw cap vials, pencil, paper, a flat white porcelain pan, and 70% ETOH. Collecting techniques vary with the species involved. For free living species approach the breeding site carefully because larvae are sensitive to vibrations and shadows. For anopheline species skim the surface of the water with the dipper. Culicine species are more active and a quick dipping motion with the dipper provides the best results with this group. For a control program, regular larval dipping stations are established so that the average number of larvae per dip can be used as an index of control effectiveness. Container, treehole, crabhole and leaf axil breeders can be collected with a pipette or aspirated with a suction bulb attached to a piece of rubber tubing. *Mansonia* and *Coquillettidia* larvae are collected by pulling up aquatic vegetation (sedges, cattail, etc.) which is rinsed in a pail of water. Since the larvae drop off of the plant quickly, it may also be productive to scoop up samples of bottom sediment with a bucket and rinse this material with a strainer. Transfer the rinse and strained water in small amounts to a small procelain pan and examine it closely for larvae.

b. *Curation.* Never mix specimens collected on different days or from different breeding sites. Concentrate all of the larvae from a single collection in 2.5 ml (1 in) of water in a small test tube, and heat it with a match or a Bunsen burner until bubbles begin to reach the surface. Pour the contents into a small open container. Pick up the larvae on the point of a probe or insect pin and drop them into a novocain tube containing 70% ETOH. These tubes may be obtained from dental facilities. Isopropyl alcohol (70%) may be temporarily substituted as a preservative but it should be replaced with ETOH when possible to preserve specimen quality. Insert a small, loosely compacted piece of cotton into the tube at a point just above the larvae and well below the surface of the alcohol. Write the collection data with a soft lead pencil or pen with india ink on bond paper labels. When using india ink, allow the label to dry. Then push the label into the tube above the cotton. Insert the top novocain tube stopper using a needle to release the compressed air. Make sure that no bubbles exist in the section of the tube holding the larvae because repeated passage of air bubbles over specimens can cause damage. One week following preservation re-examine the tubes. If bubbles have formed, release the trapped air with a long needle. Wrap the tubes carefully in cotton or other soft packing material and package them in a crush-proof container for mailing.

2. *Mosquito adults.*

a. *Collection.* The collection of adults requires consideration of the species' behavior. Since no single method attracts all species, a combination of methods is desirable. Light traps attract phototrophic species. The New Jersey light trap is widely used for this purpose. Basically it is an open metal cylinder protected by a conical top. The insects attracted to a 25-40 watt white light, are drawn by an electric fan into a collecting jar containing a piece of dichlorvos-treated resin strip or PDB. A perforated paper cup suspended from the rim of the jar keeps the mosquitoes dry, clean and easy to remove. The fan in a New Jersey light trap requires 110 volts and can be turned on and off by an electric timer or photoelectric cell. Another type of trap is the CDC light trap which weighs only about 0.8 kg (1 3/4 lb) and can be operated on any 6 volt DC source. The use of a 30 amps/hour motorcycle battery gives up to five nights' operation without recharging. Although not as effective as the New Jersey light trap, it has the advantage of being portable. The live adults are collected in a cage of nylon netting and can be used in virus isolation studies. Proper trap placement is very important. Place the traps about 1.5 to 1.8 m (5 to 6 ft) above the ground, and avoid competing light sources, windy areas and industrial fumes. Also avoid trapping in livestock and bird roosting areas because mosquitoes are less easily attracted to light after taking a blood meal. Optimum results will be obtained in areas with adequate vegetation and high humidity. A shift of a few meters can make a substantial difference in results. Therefore, if trapping results are poor, change the trap locations before reporting the absence of mosquitoes in the area. In addition to indicating what species are present, trapping signals the emergence of males which emerge before the females and congregate near the breeding site. This allows treatment of a population before a major increase in the number of adult females occurs, thus, lowering the breeding potential. For some of the anopheline species that are not strongly attracted to lights, collections are made at resting sites. This is done by sweeping the vegetation with an insect net or by using an aspirator (or killing tube) and a flashlight. The aspirator is made of rubber or plastic tubing joined to a piece of rigid clear plastic tubing [0.9 cm (3/8 in) inside diameter] with a piece of netting in between for a filter. Cool, dark and humid areas are checked, including culverts, bridges, caves, overhanging stream banks, wells and building. In areas with few resting sites a variety of artificial devices such as boxes, barrels and kegs can be established. Biting collections may also be made by using either a killing tube or aspirator. If the sampling time and place of biting collections can be standardized, the counts per minute will yield data useful in evaluating control procedures. When a large population of daytime biters is present and specimens are not desired, it is more practical to use a landing rate count than attempt to use an aspirator. For a detailed discussion of mosquito collection, a "Mosquito Surveillance Guide" is available from EPMU's and DVECC's.

b. *Curation.* Adult mosquitoes are very delicate and must be handled carefully to avoid loss of scales or appendages essential to their proper identification. Natural scale discoloration, caused by moisture, must also be prevented. Consequently, to avoid contact with moisture that condenses in ethyl acetate or chloroform killing tubes when exposed to heat or the sun, remove the mosquitoes as soon as they are killed and

periodically wipe the barrel of the tube dry. Reared adult specimens to be preserved should be kept alive for at least 12 hours to allow them to harden, then pack them in pill boxes. Pill boxes are preferred over glass, plastic or metal containers because they are permeable. This helps to prevent any fungal growth caused by a build up of excessive moisture from the drying specimens and heat from the environment. Prepare the box for shipping by cutting two strips of soft tissue paper slightly larger than the lid. Place a thin, very light wisp of cotton in the bottom of the box, and cover it with one paper slip. Being slightly larger than the box, the paper's tucked edges against the sides will hold it firmly. Place the collected mosquitoes on this paper and tuck in the second paper slip until it just contacts the mosquitoes. Be sure the covering slip will not become dislodged. Over the top paper slip, add another wisp of cotton that is barely large enough to touch the lid when it is closed. Do not, under any circumstances, pack mosquito adults between layers of cotton, cellucotton, or similar fibrous and heavy materials. The collection data should be placed within the container between the lid and the top layer of cotton. Data may also be recorded on the lid of the container. Packing is completed by placing the containers in an exselsior-padded and properly labeled mailing tube.

3. *Flies.* Adult flies can be collected with an insect net or a variety of traps. If a natural attractant is available use a 76mm (30 in) diameter wire screen cone with an inverted screw-top to trap domestic flies. Place the cone over the attractant and flies. Then place a dark cloth over the cone. The cone is then agitated and the flies will move upward toward the light in an effort to escape. The sliding door of the trap is then closed, blocking the mouth of the bottle. Lacking a natural attractant, all purpose baits consisting of a mixture of fish heads, chicken entails, vegetables and fruit may be used. The cylindrical screen trap placed several inches above the bait should have a funnel shaped, upward-pointing bottom, and a removable top. As the flies leave the attractant, they are funneled into the trap. Since they generally do not fly downward to escape and the funnel opening is difficult to find, few flies will escape. Fly larvae (maggots) and adult specimens of delicate flies, such as sand flies, culicoid biting flies, eye gnats and black flies, may be preserved in 70% ETOH as described for mosquito larvae. Larger flies, such as domestic species, should be preserved in dry pill boxes as detailed above for mosquito adults, except that heavier cotton cushion layers will be needed because of the greater weight of the specimens involved.

4. *Ectoparasites.* Particular effort should be made to collect ectoparasites from wild rodents suspected of being reserviors of disease (e.g., plague, tularemia, etc.). Because fleas leave the host shortly after death, it is best to capture the animal alive and sacrifice it with chloroform in a closed container from which the detached insects can be collected. Leave the animal in the container from which the detached insects can be collected. Leave the animal in the container at least 30 minutes after death to ensure that the ectoparasites have also been killed by the chloroform exposure. A fine tooth comb is used to comb fleas onto white paper. Another technique for collecting fleas, as well as some mites, is to place the dead host in a jar of water containing a detergent and swirl the water vigorously. After filtering the water with a filter paper lined funnel, place the specimens in 70% ETOH as described for mosquito larvae. Neither combing or detergent baths will remove stick-tight fleas or ticks. These must be picked off with forceps during a thorough host examination. When examining buildings for adult fleas, white pants or coveralls will allow the adults to be seen quite readily when they move onto the legs. They can then be collected with a small alcohol moistened brush. When examining animals for ticks, care must be taken in their removal so that the mouth parts are not broken in the host's skin. Ticks may be collected from likely host habitats by walking through grassy or bushy areas and removing them with forceps from the clothing or from a piece of cloth used as a drag. The latter is constructed by attaching a piece of white flannel about 1 x 1.5 m (1 x 1.5 yds) by two corners to a stick approximately 1m (1 yd) long. A cord is attached to both ends and the device is dragged over grassy areas beside trails and other potentially infested areas. The same device without the cord can be brushed over shrubbery. Collected ticks are placed in 70% ETOH. The detergent technique described for fleas yields some mites but chiggers are collected by scraping the skin or, in the case of dead animals, portions of infested. skin may be cut off and preserved in alcohol. Another method is to place a white or black card on the ground. Mites are counted and/or collected with a small, alcohol moistened brush as they cross the card. Lice and bed bugs may be collected from clothing and bedding with forceps or combed from the hair with a fine-tooth comb and placed in 70% ETOH.

5. *Miscellaneous arthropods.* Insect larvae, spiders, scorpions, centipedes and millipedes may be preserved in vials of 70% ETOH. When corks or rubber stoppers are used to close vials, it is best to seal them with melted paraffin or parafilm to prevent fluid loss through evaporation. If 5% glycerin is added to the 70% ETOH, the collected specimens will not shrivel, shrink, or dry if the alcohol is accidently lost. Larger, hard bodied insects such as reduviid bugs, cockroaches and beetles should normally be preserved dry in pill boxes but they can also be placed in tubes or vials of 70% ETOH.

(d) *Pinned specimens.* If possible, it is usually better to pin insects for mailing because they are less likely to break if properly packed. These specimens may be pinned inside a closed vial with a cork bottom or in a Schmitt, cigar or other sturdy box with a cork, balsa wood, corrugated cardboard or composition bottom. The pins should be securely anchored in the substrate. Large specimens should be braced with additional vertically placed pins to prevent them from rotating and destroying adjacent specimens. Insects with elongated abdomens should be supported with crossed pins, thereby preventing the abdomens from breaking off in the event of rough handling during shipment. For ease of extraction, the cardboard can be slotted or a piece of adhesive tape can be attached to the center for use as a handle.

Fasten the lid securely and pack the box or boxes in an outer stout carton padded with a lining of excelsior, styrofoam or similar packing at least 5cm (2 in) thick.

(2) *Vertebrates.*

(a) *General.* Vertebrate specimens should be collected whenever proper identification is in doubt. Instructions for the collection and preservation of such specimens can be obtained from personnel at the nearest DVECC or EPMU.

(b) Shipping. Packages of vertebrate specimens should be marked "Skins of _____ " or "Preserved for Scientific Study" if the specimens are in a preservative fluid. Parcels should clearly show any legal endorsements required by the state, territory, or district in which specimens are mailed (see (l)(a) and (b) above). An advanced letter should be sent to the addressee notifying him of the shipment. All packages must be wrapped to prevent any fluids from leaking through the package and damaging other mail.

8-57. Disposition of Collections

(1) Collection of specimens should be sent to the appropriate DVECC or EPMU for identification. Specimens which cannot be identified by the center or unit involved, or which are considered of sufficient significance for museum use, 'will be sent to the Navy Environmental Health Center (Code 63) for further study and disposition. Complete data should always accompany the shipments (Article 8—55). An advance letter of shipment notification, an appropriate request for services, and any comprehensive and pertinent questions for which answers are specifically required should also be sent.