

**Armed Forces Pest Management Board
Technical Guide No. 31**

**Operational Washdown and
Agricultural Inspection Preparation for
Military Conveyances and Equipment**

**Supplement 4: Guide to Land Snail
Identification and Management**



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Foreword

This Technical Guide (TG) describes procedures, outlines responsibilities, and defines requirements for preparing military conveyances (vehicles, vessels, aircraft), rolling stock, equipment, cargo and unit and personal gear to comply with agricultural and public health pest exclusion requirements for movement of ships, aircraft, equipment, and personnel, particularly from locations outside the United States (US). Note that TGs are not policy documents; they provide best management practices and technical guidance for the US Department of Defense (DoD) operations, pest management, natural resources and other DoD communities. Accordingly, TGs should not be construed or referenced as policy.

This TG will be reviewed and updated periodically to reflect current information. Users are encouraged to submit comments and suggestions for improvement to the Armed Forces Pest Management Board, via e-mail to osd.pentagon.ousd-atl.mbx.afpmb@mail.mil; by mail to Director, AFPMB, US Army Garrison–Forest Glen, 2460 Linden Lane Bldg #172, Silver Spring, MD 20910-7500; by telephone at (301) 295-7476; or by fax at (301) 295-7473.

Policy and points of contact questions related to customs and border protection and agricultural washdown preparations and inspections should be forward to USTRANSCOM/TCJ4-PI via email at transcom.scott.tcj5j4.mbx.pi-customs@mail.mil.

Policy, guidance and points of contact questions related to animal pathogen sanitation, or disinfection requirements, such as those required for African swine fever or foot and mouth disease, often associated with customs and border protection and agricultural washdown preparations and inspections, should be forwarded to DHA.NCR.VETERINARY.MBX.VETSVCS-DSCA@mail.mil.

DoD pest management policy, guidance, and point of contact information is accessible on the AFPMB website: <http://www.acq.osd.mil/eie/afpmb/>.

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Land Snail Identification and Management

Taxonomy, Biology and Ecology of Terrestrial Snails

Land snails are one of the most common problems in and around shipping containers. Land snails are members of the class Gastropoda, the largest and most varied group of the phylum Mollusca, which includes slugs, and limpets as well as snails. They are found in marine, freshwater, and terrestrial habitats. Gastropods have retained the primitive, flat, ventral foot for crawling, but in many other ways have evolved significantly from the ancestral stock. They have all undergone torsion in the general body plan so that the digestive tract is no longer a straight tube, but the anus has coiled to lie on the side and usually near the head. Most gastropods have a coiled shell which corresponds to the coiled visceral mass.

The terrestrial, pulmonate snail *Helix pomatia* Linne typifies the biology and habits of this group. The pulmonate snail is hermaphroditic, and each gravid snail deposits batches of gelatinous-covered eggs in damp places or shallow burrows. Development is direct, the young emerging as minute snails. Movement is by waves of muscular action on the ventral side of the "foot" over a slime trail of mucus secreted by a gland below the mouth. The type of food varies, but snails prefer tender, young green plants. Food is held in the "law" and rasped off in small bits by the feeding apparatus or radula. Snails tend to hide during the day, though they often feed on cloudy days. Terrestrial snails are mainly nocturnal, but following a rain may come out of hiding during the day. Temperature and moisture, rather than light, are the main factors to account for their nocturnal habits. Native snails may be found everywhere but prefer habitats offering shelter, adequate moisture, an abundant food supply and an available source of lime. Forested river valleys generally provide such habitats, and those with outcrops of limestone usually show the most abundant and varied mollusk faunas. Snails are very adaptable to times of drought and adverse climatic conditions. During these periods, the snail closes the shell aperture with a mucus flap (epiphragm) which hardens and prevents desiccation. Snails can remain in this dormant state (aestivation) for years, breaking dormancy when climatic conditions are favorable again.

Families of Terrestrial Snails of Agriculture and Quarantine Significance Intercepted in Military Cargo

Family Achatinidae: The giant African snail, *Achatina fulica*, Bowdich is the largest (shell length of 5 inches (125 mm) or more), most voracious and reproductively prolific snail to have been introduced into this country. Its origin is south of the Sahara in East Africa and it is established in Asia and the Indo-Pacific Islands, including Hawaii. The giant African snail was inadvertently released in California after World War II and in North Miami in the 1970s. In each instance, eradication efforts were successful, but very expensive.



Family Bradybaenidae: The most well-known member of this family, *Bradybaena similaris*, is a snail of medium size (approximately 12-16 mm in diameter). The shell is wider than high, thin, narrow with a rather depressed spire. The shell is white to greenish yellow, often with a single, spiral, chestnut band. It probably originated somewhere in China but is now widely distributed throughout the world. *B. similaris* is a severe pest of coffee trees and is found wherever this crop is grown.



Family Helicidae: This family is the most prevalent and contains the largest of the European snails, including *Theba pisana* (the white garden snail). Distribution of this group is from the countries bordering the Mediterranean Sea. The shells of the Helicidae are usually medium to very large in size, thick, and often brightly colored, but there is an immense range of size, shape and coloring between and sometimes within species. Members of the family are found in a very wide range of habitats, but there are, within the family, groups of species which share similar features of habitat, size, and way of life. Recently, the white garden snail, *T. pisana*, has become established in San Diego County, California.



Family Succineidae: *Succinea horticola* Reinhart is the most important species of this family and is found mainly in the Orient (i.e. China and Japan). *S. horticola* is also found in Greece and Italy. This snail is a very severe pest of greenhouse plants and grasses.



Family Spiraxidae: *Euglandina rosea* (Férussac 1821), the rosy wolfsnail, a large shelled snail, measuring up to 76 mm in height and 27.5 mm in diameter, is thick and has prominent growth lines. The shape of the shell is fusiform with a narrow ovate-lunate aperture and a truncated columella. Typically, the shell color is brownish-pink. Adults measure 7-10 cm in length.

Native to the Southern United States, this snail was released as an attempted biological control agent of the giant African snail. Live specimens were sent to Hawaii in 1955 (Mead 1961) and although feeding on *Achatina* was observed, as well as on the Asian tramp snail, *Bradybaena similaris* (Férussac, 1821) and native tree snails (Hart 1978), no real control was achieved. The rosy wolfsnail reproduces rapidly and in Hawaii, was responsible for the extinction of at least eight native species of land snails. Similar results occurred in other areas where this snail was released or introduced. Individuals live up to 24 months and adults lay 25 to 35 eggs in a shallow pocket in the soil. These hatch after 30 to 40 days.



The rosy wolfsnail, *Euglandina rosea*. Photograph by Lyle, J. Buss, University of Florida.



Top view of the rosy wolfsnail, *Euglandina rosea* (Férussac, 1821).
Photograph by Paul M. Choate, University of Florida.

Prevention of Snail Entry and Establishment

Following are methods and procedures to be used by Department of Defense personnel located in overseas areas to prevent contamination of materials with land snails and guidelines for decontamination of cargo both prior to shipment and after arrival.

Supplies and retrograde cargo which have not been adequately inspected and are subsequently shipped to CONUS ports of entry may be the source of serious problems if applicable quarantine procedures are not rigidly observed. Some examples are given below:

- A few contaminated items intermixed with snail-free cargo loaded on a vessel may require fumigation of the vessel and entire cargo even if some portions were fumigated prior to landing. This intermixing has been particularly troublesome when shipments originate at different locations and it may be impossible to establish responsibility for the contamination and to prorate decontamination costs among the shippers on an equitable basis.
- Initial cargo inspection prior to loading aboard ships or aircraft may not always reveal the presence of snails. If contamination is discovered after cargo is unloaded, it may have to be reloaded aboard ship for fumigation if adequate facilities are not available ashore or if adverse weather conditions preclude an effective treatment on an exposed dock area.
- The risk of pest introduction is elevated when contaminated cargo is discharged on docks or at military installations in CONUS. Many installations are generally not staffed or equipped to decontaminate snail-infested cargo and the risk of introduction is magnified when fumigation support is not quickly forthcoming. Snails which became established in Florida and California are a very serious threat to the agricultural industry in those states and control/eradication measures are a tremendous expense.
- Decontamination at ports of entry, particularly of surface-borne cargo, has been expensive. Fumigation charges may exceed \$40,000 per ship. In addition, there has been considerable delay in the movement of high priority cargo resulting from fumigation.
- Current directives prohibit the fumigation of ammunition aboard ship at CONUS ports. Therefore, the originators and the carrier of the shipment must take special precautions to ensure that all ammunition shipments are snail-free.
- The shipment of contaminated cargo to locations in friendly countries where the destructive snails are not known to be present could have serious consequences if the US were held responsible for introducing the pests and for the costs associated with their eradication. The spread of these snails to other areas would compound the present problems which for the most part have been confined to cargo from the Mediterranean area.

General Military Operational Considerations

The problem of agricultural pests associated with retrograde military cargo is not entirely new in the history of Department of Defense overseas support operations. There will be no relief from the risks of pest introduction unless proper attention is devoted to implementing preventive control procedures at the source.

In order to prevent the dissemination of pest snails, it is necessary to use three control phases simultaneously as follows:

- Prevention Phase – To protect supplies from becoming infested while in storage or awaiting shipment. This protection should include thorough and complete surveillance by appropriate personnel prior to loading.
- Correction Phase – Designed and implemented by engineer-entomologist services to reduce and/or eliminate local snail populations by chemical and physical means.
- Decontamination Phase – To decontaminate infested materials that are to be returned CONUS or shipped to other military bases and locations in overseas areas.

As preventive and corrective control programs are implemented, and their effectiveness increases, the need for decontamination should be reduced.

The snail control and decontamination procedures presented here are based upon experience and research in both field and laboratory studies. Therefore, the methods and procedures outlined should not be modified unless prior approval has been obtained from the area, district, theater, or command entomologist and appropriate U. S Department of Agriculture APHIS representative.

Supply Storage

The most important phase in the movement of snail-free cargo is that of utilizing effective storage practices and techniques to prevent infestation. The following procedures should be incorporated into a preventive control program:

- Store supplies awaiting shipment in warehouses. Land snails do not normally enter buildings to aestivate, therefore, enclosed structures provide the greatest protection against infestation.

- If warehouses are unavailable, use paved open storage and an aggressive snail control program. Areas covered with asphalt or concrete provide the most suitable and lasting types of ground cover for storage areas and less maintenance will be required.
- If neither warehousing nor paved areas are available for supply storage, suitable storage must be constructed. A layer of well-compacted, crushed stone about 6 inches deep should be laid on the soil, the depth depending on the soil conditions. Placing such an impermeable barrier over the soil will eliminate food sources and break an important link in the reproductive cycle of the snail. Remove the vegetation and top soil from a strip, 20 to 25 feet wide, around the perimeter of this area and apply a soil sterilant (if possible) to prevent growth of vegetation. This type of site can also be used for decontamination prior to the shipment arriving in CONUS or other snail-free military locations.
- Permit only snail-free supplies in warehouses or snail-free storage areas. Do not mix infested cargo with snail-free cargo in storage or in transit.
- Store transport containers, when not in use, in snail-free areas to prevent infestation. CONEX containers have been a major source of snail interceptions at the ports of entry in the past. Shipping containers, including those for household goods, must not be stored or allowed to remain on the open ground. Cargoes or household effects infested with snails should never be packed in containers for shipment.

Cargo Movement and Transportation of Supplies

Snail-free retrograde cargo and household effects can be satisfactorily moved from snail-infested areas to CONUS and to other overseas locations, provided proper storage sites were selected, meticulous pre-inspections were performed and when necessary, effective snail control and fumigation were conducted. These factors must be strictly observed and enforced at the points of origin and embarkation.

Inspection for Snails: No movement of snail-infested cargo should occur unless that species of snail is already established in the area. This is particularly applicable in the movement of cargo from country-to-country, between non-contiguous land masses, and from off-shore island(s) to mainland port cities. A thorough inspection should be made of all military materials and personal household effects of military and civilian personnel prior to movement from a known snail area to any snail-free destination. Because of the tendency of snails to hide in crevices or to crawl into holes or other openings, it will be necessary to inspect the interior, as well as the exterior of containers, when potential snail entry holes are noted. The smaller snails resemble ordinary pebbles in color and markings as well as size; therefore, a significant infestation could be overlooked during a superficial inspection of contaminated articles. Occasionally, the presence of snails may be indicated by a faint slime trail. Shipping container boxes, particularly when they have been in contact with the soil, offer a number of havens for snails — the bottom

runners (some of which are hollow), the lift hook slots, and the occasional rust holes in the more weathered boxes. All sides of each likely item must be closely examined, noting in particular any cracks, crevices, or other areas not readily observable. Fork lifts will frequently be required for inspection of bottoms of boxes, crates, and the heavier articles. Steel cylinders present good hiding places – under the screw cap and adhering to the pallets to which cylinders are often fastened. Pipes of all types are especially attractive to snails since caps or plugs are seldom feasible. In the case of tracked vehicles, cranes, and other heavy equipment, with so many crevices in which snails can hide, steam or water-jet cleaning is recommended in lieu of or in addition to examination. To prevent the contamination of military or commercial cargo carriers during the movement of supplies from one location to another, only snail-free cargo should be shipped. In the examination of ships before loading, attention should be given to the bottoms of holds and ledges around the sides. Hold bulkheads near the engine room, being warmer, are favored snail sites. **Note:** Snail-free cargo should never be loaded until holds have been thoroughly inspected and found or made snail free.

- US port of entry inspection by Plant Protection and Quarantine: At the US Port of Entry, items which could harbor snails will be subject to inspection by Customs and Border Protection (CBP) Agricultural Inspectors. Standard documents such as vessel or aircraft manifests, general declarations or cargo load plans should be presented to CBP upon arrival at the first US Port of Arrival and/or discharge. These documents will be used by CBP to determine if inspection is required for military cargo or containers transporting military cargo. Generally, CBP examines containers and military cargo originating from certain high risk snail areas of the world such as the Mediterranean and Pacific basin. If quarantine significant snails are found, CBP may refuse entry to the cargo or require the item be fumigated by USDA APHIS to kill the snail pests.
- Other factors involving cargo movement:
 - Equipment (forklifts, tractor-trailers, trucks, and railcars) and materials (pallets, dunnage, and tarpaulins) utilized in the storage and transportation of non-infested supplies must be snail-free. This equipment, when not in use, should be returned to snail-free areas. Equipment that is utilized to handle or transport snail-infested supplies should not be reused unless the equipment has been decontaminated
 - It is important that adequate procedures be established to prevent snail "stowaways" in personal household effects of military personnel. Shipment boxes used for household goods should not be placed on the ground. Lawn furniture, garden hoses and tools, sporting goods (boats, motors, etc.) bicycles, motor scooters, utility trailers, tires, and other items that are allowed to remain outdoors must be decontaminated before packing for shipment from snail-infested areas.
 - Household furniture and packing materials should never be placed on the ground or lawn while being prepared or packed for shipment.

Snail Control

Military installations and deployments in the Mediterranean region and other high risk areas should establish snail control programs to reduce snail populations on the installations, to control the snails in the vicinity of transportation terminals and to eliminate snails from storage areas. The control of land snails can be accomplished prior to infestation of materials by establishing sound and aggressive physical and chemical control programs. In most instances, both programs should be utilized when practical.

Physical control: Physical control measures are of definite value in reducing snail populations where chemical control is too hazardous or expensive. During the summer months when the Mediterranean snails are aestivating, their metabolism is greatly reduced, therefore, chemical control is not effective, and physical control is the only method that can be satisfactorily used. Physical control has been found to be of value in reducing populations of *Theba pisana* in open fields bordering open storage areas in North Africa. Specific physical control measures which would routinely apply as preventive measures in countries with highly endemic snail populations are described as follows:

- **Burning-over** – Burning vegetation on which aestivating snails attach will reduce snail populations. Burning is most effective during the dry season when the vegetation is dry and the majority of snails are aestivating on the vegetation above ground. The systematic use of flame throwers or commercial weed-burners is effective in reducing snail populations along fence rows, and in areas where other measures may not be practical.
- **Plowing** – In open fields, adjacent to outside storage and on-base housing areas, plowing the soil twice a year has been found to reduce both *Theba* and *Cochicella* populations. Cultivating the soil in late autumn destroys many of the immature and adult snails, as well as the eggs that have been deposited in the soil.
- **Disking and culti-packing** – This is helpful in reducing land snail populations in areas where plowing may not be practical because of thin top soil or where erosion may be a serious problem. The mechanical action of the disc and culti-packer will eliminate many adult snails, while stirring the soil will destroy many eggs.
- **Storage** – Equipment utilized in grounds maintenance work should not be parked, stored, or allowed to remain in snail-infested areas. This equipment should be cleaned and returned to the equipment storage area at the end of each work day. The care of equipment prevents infestation and spread into storage areas.

Chemical control: Chemical control of exotic snails typically employs metaldehyde, methiocarb (Mesurol®), salt, or combinations of these chemicals with other molluscicides in a myriad of bait formulations or foliar sprays.

- Metaldehyde treatments applied during dry climatic conditions are usually more successful than the degree of control achieved during damp, high humidity conditions at which time snails are likely to be more active. The principal toxic effect of metaldehyde is through stimulation of the mucous glands which cause excessive sliming, leading to death by dehydration. Metaldehyde is toxic to slugs and snails both by ingestion and absorption by the "foot" of the mollusc.
- The pesticidal properties of methiocarb are similar to the toxic action of other carbamates which prevent effective nerve transmission by inhibiting the enzyme acetylcholinesterase.
- In addition to these molluscicides, sodium chloride, common table salt, is an effective dehydrating agent. It may be applied as a 12-inch barrier application on the perimeter of known/suspected snail-infested areas. During periods of rain or high relative humidity, salt barriers should be renewed frequently. Molluscicides are ineffective during periods when snails are aestivating.

Decontamination Procedures for Snail-Infested Cargo

Freshwater washdown (high pressure) is the most accepted, effective and inexpensive method if infestation is obvious and snails are superficially attached. Prior to high pressure wash down, all soil plant material and any other debris should be removed by scraping, brushing or any suitable and appropriate method that will remove gross contamination prior to the actual wash down. The military inspector, after contacting APHIS should be aware of the ultimate disposition of all live and dead snails and any plant material/soil which has been removed during the wash down procedures. If this material does not enter a sanitary sewer system where chemical treatment would be routine, other steps should be taken. A suitable option would be to conduct the cleaning procedure(s) on a concrete or asphalt hardstand which would permit collection and proper disposal of material removed during wash down.

Live steam washdown is an effective method, providing equipment and facilities are available. Live steam is highly lethal to molluscs, but extreme safety precautions must be followed both for the safety of the operator and the vehicles or equipment to be cleaned. These would include the use of protective rubberized outer clothing, rubber boots, rubber gloves and protective face and head gear. The peripheral area of the live steam decontamination area should be well marked, and protective barriers should be in place before beginning the cleaning procedures. Extreme care should be exercised when steam is used to clean metal surfaces because of the burn hazard of the heated metal.

Chemical Methods: With the use of devices for measuring gas concentrations, fumigation under temporary enclosures has become generally accepted as a reliable method of snail eradication. Its adaptability for use under a variety of circumstances makes it an irreplaceable method in many instances. The use of a temporary enclosure for the fumigation of snail-

infested cargo certainly contains elements of risk beyond those of an approved fumigation chamber. However, it can be used effectively against many plant pests and when properly managed should not present any serious safety hazard. Fumigation must be performed only by properly trained and certified applicators. APHIS is certified to oversee fumigations.

- Fumigation Procedures:
 - Methyl bromide (MB) is one of the principal fumigants used under tarpaulins for shipboard, and/or warehouse fumigations. It is a colorless gas and is usually supplied as a heavy, volatile liquid under pressure. The gas volatilizes when released from containers at ambient temperatures of 400 F (4.4 C) or above. In the actual fumigation procedure, vaporizers and circulatory fans are used to increase diffusion and penetration of this fumigant.
 - Like all effective fumigants, MB is very dangerous to humans and when improperly handled may produce serious consequences. Fumigations should always be under the supervision of a responsible person who is properly certified and thoroughly familiar with the fumigant and the hazards that may prevail. Exposure of personnel to all concentrations is to be avoided. The threshold limit value has been established at 5 ppm in air for repeated exposures, 8 hr per day, 5 days per week. A concentration of 2,000 ppm is considered to be immediately dangerous to life and health. There is also a chronic toxicity hazard from continuous exposures to low concentrations in air. However, MB poisoning, both acute and chronic, can be avoided with appropriate training. Reasonable care good Judgment, and proper safety equipment.
 - Although the commercial fumigator is responsible for producing the desired results, the military entomologist/inspector must assume a functional role during the operation. He must confer with the fumigator and decide upon the best possible method to follow. Only through familiarity with the materials and procedures involved can this be best accomplished.
 - Before any large fumigations are begun, the commercial fumigator should make sure that local ordinances are understood and followed. Police and fire departments should be notified if required by law. Public safety must be the utmost consideration; and although the military inspector cannot assume the responsibility of providing complete protection, he should be able to recognize unsafe procedures and offer advice concerning dangerous situations which may arise.
- USDA-APHIS PPQ treatment schedules for snails are accessible online at http://www.aphis.usda.gov/import_export/ -- see Treatment Manual 5-5-1, Treatment Schedules, T400 - Schedules for Miscellaneous Products, http://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/treatment_pdf/05_05_t400schedules.pdf, 05/2011-61.

Post-Exposure Procedures for Retrograde Military Equipment

Notification of Infestation – Notify the nearest representative of APHIS of a known or suspected snail infestation on any vehicles, weapons, or any other type of military equipment or gear which is being returned to CONUS from a foreign country in which snails declared to be under quarantine by APHIS exist.

A list of assigned APHIS inspectors, location of work sites and their telephone numbers should be maintained at every port-of-entry where military equipment would be received. This list should be reviewed and updated at least annually so that it will be current in the event of an urgent notification.

Contaminated military cargo, equipment, and/or household effects under USDA quarantine should never be moved any further from the point of disembarkation than is essential to effect the necessary decontamination procedures.