CHAPTER
11

Low-risk Pest Management

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Information in this chapter is provided to help ensure that wherever birds are being maintained, pest problems can be dealt with effectively and potentially hazardous conditions can be avoided.

The Environmental Protection Agency's (EPA) classification of pesticides as "low risk" refers to the potential effects in humans, not companion animals or wildlife. This should be kept in mind when a chemical pesticide is being promoted as a "low-risk" alternative. Check with Rachel Carson Council (RCC),[8,16] Biointegral Resource Center (BIRC)[13] or other organizations for non-chemical alternatives that can represent low risks to pets, wildlife and the ecosystem, as well as to people.

Most veterinarians have traditionally used pesticides to control the parasite problems of their patients. However, many of them have adopted a hands-off approach toward routine environmental pest control for ants, cockroaches, rodents, etc, leaving this to the specialized domain of certified exterminators and trusting them to use the products properly. A recent incident serves as a warning to animal health care professionals to reevaluate this practice. The incident happened in January 2003 following use of the intensely toxic rodenticide zinc phosphide. The fatal poisoning of two valuable red pandas at the National Zoo resulted in part from failure of veterinary medical personnel to give sufficiently critical oversight to rodent control procedures.

A promising outcome of the zinc phosphide incident has been the National Zoo's adoption of Integrated Pest Management (IPM) procedures for its animal facilities. IPM in principle involves greater reliance on a variety of low-risk pest management practices and the use of toxic chemicals only as a last resort. Pest problems where companion birds reside can be controlled with similar strategies.

Those in charge of keeping animals healthy cannot afford to delegate pest control measures without first making certain that the intended procedures provide the lowest possible risk to non-target individuals. In the future, with this greater awareness, we are confident that veterinarians will be able to promote low-risk pest management methods for use on premises where animals are under their care. This can happen only if veterinarians understand certain concepts and how they work.

Justifications for avoiding use of chemical pesticides near companion birds can be similar to those given by the United States Environmental Protection Agency (USEPA) for avoiding them around another vulnerable population — children: "Chemical pesticides…may cause a range of harm, such as cancer, (as well as) acute or chronic injury to…(respiratory), nervous, reproductive, endocrine and immune systems…"[22] There are additional reasons for bird owners to avoid chemical pesticides. Tests for acute toxicity of pesticide products are performed on rodents. Since birds are generally more sensitive to chemical pesticides than most mammals including rodents, the required tests may not be predictive for toxicity in birds.

Sensitivities to chemicals can vary widely among avian species and it is not possible to designate a single representative bird species to serve as the surrogate for all others in testing pesticide hazards.[9] Due to birds' increased vulnerability, they have been used to provide early warnings of toxic environmental conditions potentially harmful to those less sensitive, for example, the canaries were used to protect coal miners from asphyxiation due to methane gases that replace oxygen and tend to collect in coal mines.

Sentinel birds can suffer serious adverse consequences in the process of protecting people.[12,19] If environments are safe for birds, however, then people sharing homes with them will likely benefit as well.

A CASE HISTORY

Before it was banned in 2000 for indoor application, the organophosphate insecticide chlorpyrifos was widely used. Chlorpyrifos treatments for cockroaches in a home-based aviary resulted in the eventual loss of the entire breeding bird population of 15 pairs and their offspring. The toxic nature of the chemical as well as actions by the parties involved contributed to this unfortunate outcome. The applicator called the pesticide "safe" and did not appear to know its potential danger to birds, although the owner specifically questioned him about it. The aviary owner accepted the exterminator's assurances of safety and failed to get a second opinion from those knowledgeable in pesticide toxicity to make certain that the pest control methods used truly afforded the lowest possible risk to birds. In an ironic twist, the owner was able to collect financial compensation for theoretical damage to his own health that the birds' deaths had indicated.[12]

COULD CHEMICAL PESTICIDES IN USE TODAY RESULT IN BIRD INJURIES?

Although chlorpyrifos and diazinon are no longer available for indoor use in the USA, neurotoxic chemicals (including cholinesterase inhibitors, pyrethroids as well as newer entities such as fipronil) are registered for indoor use and can contact a pet bird through diffusing from application sites such as rugs, furniture, the skin of a dog or cat, and bait stations, even if the bird is removed during the actual application process. Two newer insecticides, fipronil and imidacloprid, have been associated with adverse reactions in people and pets when used in flea control programs (J.H. Gainer, personal communication, 2003). Both insecticides are registered for additional uses in and around the home.

By persisting indoors for months or years on rugs or furniture, certain chemical pesticides may present the potential for adverse effects. When applied outdoors, these same chemicals, plus others registered for outdoor use only, can drift indoors through open windows, contacting a caged bird kept nearby, or they can gain access from air intake ducts or be carried indoors on shoes. Birds and/or their environments may be treated with cholinesterase inhibitors such as the insecticide carbaryl (recommended for mite control) or outdated remedies such as the toxic substance paradichlorobenzene (found in moth crystals) used around cages. Further, the effects of multiple chemical exposures can be additive or even synergistic, with greater likelihood of adverse reactions occurring as a result.

Due to concern over West Nile virus, chemical pesticides may be broadcast from an aircraft or from a land-based vehicle in an effort to reduce mosquitoes. Pet birds (and other sensitive individuals) can be protected from contact with these sprays by closing windows and air intake ducts when the application occurs. If possible, a pet owner should obtain information from local governments, professional pest control companies, landscapers or neighbors who apply pesticides as to time, place and nature of the pesticide product being sprayed close to the home. Greater surveillance of marketed products is needed to collect adverse reaction information. This is especially important for products used in the home and applied to pet animals, such as those products with fipronil and imidacloprid as active ingredients.

INDOOR AIR QUALITY AND PESTICIDES

We have much to learn about the persistence of chemical pesticides indoors. However, what we do know raises troubling concerns even for those chemical agents considered to be less acutely hazardous to birds and people — the pyrethroids. Since the recent banning of chlorpyrifos and diazinon for indoor use, chemicals of the pyrethroid class have become more popular. The indoor half-life of long-lasting pyrethroids such as permethrin, deltamethrin, cypermethrin and cyfluthrin may be up to 10 years.[17] Pyrethroids are synthetic versions of the naturally occurring pyrethrins. The latter are much less persistent and less acutely toxic, but they can still evoke allergic reactions.[6] A study reported that a percentage of the human population in contact with pyrethroid-treated carpets had vague signs of discomfort (headaches, respiratory disorders, burning eyes, dizziness, tiredness, pain of muscles, bones and joints). In a significant number of subjects, these adverse effects regressed when the carpeting was removed. A scientist working on the study has questioned, "…whether the indoor use of pyrethroids is safe enough to avoid adverse health effects."[17] Could birds be harmed due to presence of pyrethroids indoors? Perhaps yes, but we do not know with certainty. However, we do know that a number of alternative methods are available in place of synthetic chemical pesticides for management of pests, both indoors and out.

General Principles and Examples

Approaches to management of indoor and outdoor pests can be very different. Indoors, it is frequently possible to exclude the pest and employ low-risk products when necessary. Biological controls are rarely used indoors. Outdoors, exclusion is less common and biological controls are routinely used, especially by organic farmers and landscapers using biosustainable methods. Soils not designed to grow plants or crops need more pesticides.

BEFORE ANY CONTROL ACTION IS TAKEN

Accurate identification of the "pest" in question is the first step to successful management, especially when dealing with an insect. Entomologists at institutions, local extension service employees or professional pest control personnel can be useful here. Ants, cockroaches, moths, etc, may vary by species in their preferred habitats, food choices and life cycles. Accurate identification should help with selecting effective management methods, deciding whether the organism in question is a true pest, a non-threatening, neutral insect visitor or even a beneficial insect (distinguishing the latter can be especially important for outdoor pest control); see The Importance of Identifying the Pest and Lessons from a Lacewing below.

INDOOR PEST MANAGEMENT STRATEGIES

Indoor — Primary Strategy

After determining that a pest is present and there is a problem, the primary strategy involves preventing the pest from having access to a life-support system consisting of water, food and indoor habitat. Frequently, these measures are the only ones required to significantly reduce or eliminate problem pest populations. They also are prerequisites to further management actions;[5] see each pest for particulars.

Indoor — Secondary Strategy

Once the primary strategy has been implemented, further action may be needed. Secondary control methods change the pests' habitat while presenting low risks to people, pets and the environment;[5] see each pest for particulars.

OUTDOOR PEST MANAGEMENT STRATEGIES

Outdoor — Primary Strategy

Many lawn and garden pests can be avoided by taking into account the local growing conditions, choosing naturally disease-resistant plants that are also non-invasive native varieties, as well as by using organic fertilizer and compost. Awareness of soil conditions and knowledge of native plant species can help guide landscaping decisions.[21] Exclusion is used less frequently than for indoor pests, but if needed it can be accomplished with row covers, netting or fences to keep insects, birds and even deer away from plants.

Outdoor — Secondary Strategy

When pests are found at unacceptable levels and intervention is needed, the secondary strategy makes use of mechanical and biological controls. There are astonishing biological controls (most suitable for outdoors only) for use against pest insects. For example, beneficial insects such as lady beetles (ladybugs) obligingly prey upon aphids and other pests. Females of the non-stinging Brachonid wasps deposit eggs in the body of pests, resulting in the growth of wasp larvae at the expense of the pest. Such insects can be invited to a garden through selective plantings and/or they can be purchased from suppliers (see Suggested Reading for *"If You Plant It,*

Table 11.1 | Biological Control Resources

Refer to these resources for more information on biological control products and low-risk pest control methods:

1. Rachel Carson Council, Inc (RCC)
   www.RachelCarsonCouncil.com
   E-mail: rccouncil@aol.com
   Phone: 301-593-7507
2. Biointegral Resource Center (BIRC)
   www.birc.org
   E-mail: birc@igc.org
   Phone: 510-524-2567
3. Gardens Alive!
   www.GardensAlive.com
   E-mail:
   gardner@GardensAlive.com
   Phone: 812-537-8650

They Will Come" and Table 11.1). Bacteria, fungi, viruses and nematodes also are available for selective pest control. Birds can act as biological controls for insects; so can turtles, amphibians and even fish. For some large herbivores such as deer, contraception can be an effective control method. For mosquito management outdoors, see the discussion below on Mosquitoes.

EXAMPLES OF INSECT IDENTIFICATION

The Importance of Identifying the Pest

A family with two small children moved into a country house where they encountered a large number of tiny red insects that the mother believed to be fleas. Instead of spraying the house, as advised by a local exterminator, the mother contacted RCC for advice. RCC loaned her a yellow/green intermittent light flea trap that she used to obtain specimens of the insects. Her local USDA extension agent identified the insects as red clover mites, non-biting insects. Using her vacuum cleaner, as recommended by RCC, she was able to rid the house of the mites without resorting to the chemical spray.[8]

Lessons from a Lacewing

Environmentalist Anna Edey described how she became an expert in recognizing beneficial insects: "One time I saw a little cluster of 10 to 15 very fine hairs about one-half inch long protruding straight up from a hibiscus leaf. Each hair had a tiny pinhead-sized egg…at the end of it…I decided it looked like a virulent fungus…I nipped off the leaf and discarded it. Later I found out that I had destroyed the eggs of one of the most valuable beneficial insects, the green lacewing."[16]

Indoor Low-Risk Pest Management

ANTS

Ants (Fig 11.1) are one of the most abundant social insect species on earth. They can become pests in buildings as they search for water, food or places to establish

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Fig 11.1 | Ants following a crack in the cement to a food source. Ants leave a chemical trail that soap and water can erase.

colonies. Carpenter ants can cause considerable damage in moist areas by excavating galleries and establishing residences in wall voids. Ants living outdoors, however, like spiders, can be considered as non-threatening or beneficial through helping to control insects including fleas, termites and fly larvae. Denying access to ants seeking shelter indoors, as well as eliminating access to water and food, can significantly reduce ant populations along with those of other insects.

Preventing Indoor Access

Prevent access by having a sweep on the door where it touches the floor that is in continuous contact with the floor (vertical strips of plastic are not effective at keeping ants out); caulking cracks in the walls and around pipes can prevent ants from coming indoors. In an emergency, duct tape can be used to seal up an ant access area until it can be caulked.[13] It is important to be sure that the caulk does not contain volatile components that may be irritating to chemically sensitive people and pets.

Preventing Water Access

Ants are attracted to moisture, so any leaks in ceilings or walls and conditions that predispose to moisture should be promptly repaired. These can come from water pipes, downspouts, damaged roofing tiles as well as structures that do not allow for proper ventilation.

Preventing Food Access

Ants are attracted to and consume both sugar and protein, so spilled food should be removed quickly and the area wiped with a soapy water solution. Pet food dishes can be placed in a moat/dish (for example a shallow pie pan) of soapy water to prevent ant access. The soap is important to reduce surface tension so the ants drown.[13]

Food should be stored in ant-proof containers. These consist of a glass jar with a rubber seal or a plastic container with a tight-fitting lid. Ants sometimes get into the refrigerator if the seal around the door is faulty.

Kitchen areas should be kept clean and dry with frequent sweeping, vacuuming and washing up of spills. If water accumulates in a pan under the refrigerator, the pan should be regularly emptied and cleaned.

Dishes can be soaked in soapy water if immediate washing is not possible. Food containers should be rinsed of all food residues before discarding. If possible, trash should be stored outside until collected.

Water, food and droppings in birdcages can attract ants. Birds can be protected by placing a circle of sticky material such as double-sided tape completely around the birdcage stand, since ants do not like to cross sticky material.[5] The same type of sticky material also can be placed around the chain or rope from which the birdcage is suspended. Since birds can become immobilized on sticky tape, it should be placed where birds will not routinely encounter it. Sticky barriers also can be used outdoors to discourage ants, although wild birds can be at greater risk from this placement, especially if they feed on insects caught on the sticky tape. Alternatively, the birdcage stand can be placed in a moat of soapy water.

Ants seem to find extruded polystyrene foam insulation (also known as "blue board") to be ideal for locating colonies. This could be important to those considering remodeling where ants could be a potential problem.

Changing Habitat — Indoor

If ants continue to be present indoors, a non-volatile pesticide can be applied in such a way that children and pets will not be able to come in contact with it. For example, diatomaceous earth or silica aerogel, either alone or in conjunction with boric acid powder, can be placed in floor cracks and crevices and behind cabinets — sites usually accessible only to ants. Dust products should not be inhaled. Contracting with a professional for any applications or employing safety equipment if the homeowner uses them can minimize problems. Diatomaceous earth should not be the kind used in swimming pool filters; it has been polished and therefore is not effective and presents a serious respiratory hazard. Alternatively, bait stations or gel with a pesticide and an ant attractant can be applied in areas not accessible to pets or people, but where ants will pick it up and carry it to the colony. Pesticide bait stations for ants can be placed around the floor if they are not accessible to children and pets. Pesticide concentrations in most bait stations are low enough not to kill the individual ants until they have returned to the colony and shared the bait with other members. It is important to avoid using bait stations in the same vicinity as pesticides with pyrethrins acting as repellents (see Suggested Reading "What's Wrong with My Bait?").

Baits may take longer to establish control, especially if the active ingredient is an insect growth regulator. Low-risk baits should be placed where they will not come in contact with people or pets, or where a curious bird cannot find one and chew on it. Ants respond to either sugar or protein baits and they may alternate their preferences.

Ideally, the pesticide chemicals in baits should not be volatile, as that would present a hazard to sensitive people or pets. Since new formulations may not follow this rule, monitoring for adverse signs associated with placement of baits is recommended. The chemical fipronil is believed to adversely affect chemically sensitive people when present in bait stations (W. Currie, personal communication, 2002).

An innovative device, the ant guard, has successfully prevented, among other things, fire ants from gaining access to nursing home patients in their beds. In appearance it resembles the metal collar-like rat guard used to block rats from crawling up ships mooring ropes. These initial ant guards have had a chemical deterrent in the form of the pyrethroid insecticide, permethrin, painted on the inside of the collar. If the chemical component could consist of a very low-risk repellent or toxicant instead of permethrin, then it is very likely that ant guards could enjoy a host of additional uses.[7]

Carpenter Ants

A pest control professional probably should be consulted for carpenter ants, the large ants that take up residence in wall voids and woodwork but regularly travel to the outside. Frequently, individuals can be seen traveling along the outside wall from the ground, or up a shrub that is touching the outside wall, and entering the wall through cracks. These ants often remove wood and other substances that pile up in small mounds near the entry sites. These access points should be closed when the colony is treated. Indoors, the colony can be located by listening with a stethoscope for the characteristic noise made by the ants. The most easily heard sounds made by carpenter ants are intermittent clicks. The chewing sounds that they produce are softer and harder to detect. These sounds can be generated during day or nighttime hours (J. Ward, personal communication, 2004). Once its parameters are identified, the colony can be treated with boric acid powder and/or diatomaceous earth, blown into the wall void through a series of strategically placed holes drilled on the inside wall of the area they occupy. Afterward, a professional should fill in the holes.


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Fig 11.2 | Palmetto bugs (roaches) are common in the tropics around dense foliage. Food sources can encourage them indoors in any setting.

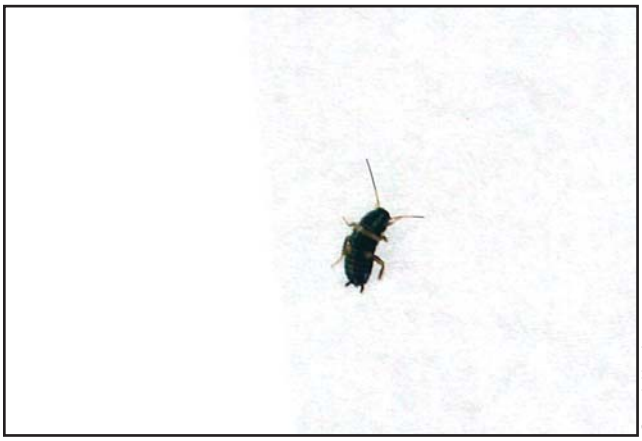
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Fig 11.3 | The small (German) roach is much harder to eliminate than its larger cousin. After eliminating food sources, a thorough (steam) cleaning and sealing of cracks is a must.

Following the wall treatment, baits can be used until all signs of the carpenter ants are gone.

COCKROACHES

Cockroaches (Fig 11.2, 11.3) like buildings because they provide all the essential elements needed for survival including shelter (sometimes called harborage), moisture and food. Cockroaches are strongly attracted to water. Although they can survive without food, they must have frequent access to water.[4] They prefer shelter where they can touch the area above them with their antennae, such as areas under cabinets.[4] Cockroach problems almost always indicate the presence of excessive moisture and poor sanitation, as well as access to harborage or shelter. Reducing access to indoors, to moisture and food can prevent infestations. Otherwise, cockroach populations are very difficult to manage because small residual populations can survive in even the most sanitary of environments. Further, residual populations can explode into major problems. The use of chemical pesticide applications can never be regarded as a substitute for either prevention or good sanitation practices. Pesticidal suppression of cockroach populations without a change in the environmental conditions that support them only gives a false and temporary sense of security and may result in chemical resistance in pest populations.[5] Cockroach food can consist of that eaten by people and pets, as well as soiled paper and glue.[13]

Preventing Indoor Access

In a home or apartment, good barrier maintenance is mandatory if cockroaches are to be denied access. This requires elimination of the holes and cracks that cockroaches use to gain entry. Before sealing see Boric Acid below. Access can be denied to cockroaches and other insects through the following measures: installing tight-fitting windows, doors, screens and door sweeps; caulking all exterior and interior cracks and holes in foundations, walls, sills, sinks, gas, water and electrical lines; covering prong holes in electrical outlets at all times; screening air and ventilation vents, open sewer lines and drains. Stainless steel baskets can be used in sink and floor drains to prevent entry of cockroaches from sewers.[13] Even the tiniest crevices must be attended to since an adult roach can hide in cracks as small as one-sixteenth inch and young nymphs can get through a void even smaller.

Preventing Water Access

Leaking faucets and pipes should be repaired. If possible, standing water should be eliminated or covered. Screens should be placed on fish tanks.[13]

Preventing Food Access

Foods should be stored in insect-proof jars with rubber gaskets or tight-fitting lids and/or be kept in the refrigerator. Food and grease should be removed each day from stoves and counters. (A fingerprint left on a countertop by someone who has eaten fried chicken can feed a roach for several days.[5]) Thorough cleanup of food particles on and under tables and counters should be done as soon as possible after meals. Dishes not promptly washed should be immersed in soapy water. Pet food, caches of crackers, nuts or even cough drops should be stored in the refrigerator between meals and dry food should be stored in plastic containers with snap-on lids.[13] Garbage should be placed in a plastic container with a tight snap-on lid.[13] Refrigerators can pose weak links in cockroach management programs because they provide heat, harborage around coils, a constant water supply and hiding places that are difficult to treat.[4]

School for Shaft Squatters

A school cafeteria was being switched to low-risk pest

management and all the appropriate steps had been taken to restrict access, remove sources of water and food, and treat known harborage, but cockroaches were still present. Finally, the pest management manager checked the hollow steel tube legs of the cafeteria tables and found a previously overlooked cockroach harborage. When this site was treated the cockroach problem resolved (W. Currie, personal communication, 2003).

Advantages of Cleaning

Regular vacuuming reduces cockroaches' food sources. Cleaning out clutter reduces nesting and breeding sites, as well as possible food sources such as glue and soiled paper.

Changing Habitat

At the first sign of a cockroach problem, sticky traps can be placed to detect the pests' preferred shelter sites and later for monitoring to determine whether control efforts have succeeded. The traps should be non-toxic and placed along the edges of walls or counters where roaches normally travel.[13] Cracks or crevices in floors or walls can be treated with boric acid before being closed by caulking or other means. See Boric Acid below.

FLEAS

The flea usually infesting USA homes is the cat flea, *Ctenocephalides felis*. Adult fleas most commonly obtain blood meals from mammalian hosts including dogs and people as well as cats. These organisms are parasites requiring a blood meal to reproduce. Fleas spend part of their life cycle on the host animal, but can develop off the host so long as they have access to droppings from the adult flea, since the droppings contain partially digested blood and serve as a food source for immature fleas. Fleas can reproduce indoors where the pet sleeps or rests, as well as outdoors during the warmer months in shaded areas such as crawl spaces under houses. Since fleas are parasites, they do not depend on non-living sources of food to survive.

Preventing Indoor Access

Animals coming into the house for the first time or after being away at a kennel or in transit should be inspected and, if necessary, bathed or vacuumed for fleas before being given access to indoors. This helps prevent seeding of the premises. If people have visited a known flea-infested area, they should change clothes or vacuum their clothes upon entering the house. The car and pet carrier should be vacuumed and washed if necessary. Once the vacuum has been used it needs to be cleaned and treated for fleas or they will escape. Residents can check for fleas indoors by walking around with white socks and looking for small, black, moving forms. Flea problems in cats can be avoided by keeping them indoors or allowing access to a deck, screened or otherwise not in contact with the ground, to prevent the cats' picking up fleas from infested ground sites.

Changing Habitat — Indoors

Washing pet bedding in hot water and drying in a dryer where possible along with vacuuming and disposing of the vacuum contents so that the eggs do not continue to develop inside the vacuum bag can remove fleas. Frequent cleaning of non-carpeted floor areas and anywhere the pet sleeps will help reduce numbers of developing fleas. Furniture and rugs can be shampooed in cases of heavy flea infestation.

A light trap for fleas can be used to locate high population levels and measure control methods. Light traps are cardboard box-like stationary devices consisting of a light source to attract the adult fleas, as well as a sticky surface, which fleas encounter and on which they become caught when they jump toward the light.

Use of a fine-toothed comb (32 teeth per inch) is recommended when combing a pet for fleas. It is best to comb pets on a white sheet to catch any eggs or larvae removed by the flea comb. Fleas should be dropped in soapy water after removing them. When combing is completed, the sheet should be picked up by the corners and taken to be washed. Cats and dogs can be bathed using flea shampoo and, before they are completely dry, combed to remove fleas while the fleas are still immobilized from the bathing procedure. Washing flea-infested clothing or other material in hot water and drying in a dryer will destroy all stages in the flea life cycle. Dogs and cats can be treated with an oral flea control medication, Program,[d] that prevents fleas from developing.

Changing Habitat — Outdoors

If a pet goes outdoors, grass and vegetation should be kept short in places where the pet sleeps or rests. Sunlight can inhibit flea development. If possible, pets and wildlife should be prohibited from having access to areas such as porch crawl spaces, which are permanently shaded and ideal for flea development. A strain of the nematode *Steinernema feltiae* can attack larval stages of fleas[20] (A. Pye, personal communication, 2003). The nematodes are sprayed outdoors on the soil where they can take up residence and help reduce numbers of viable fleas. Products containing this nematode species are commercially available[a] (see Table 11.1 for Gardens Alive!, another resource for this organism). Nematodes are not intended for use as indoor flea controls.

INSECT INFESTATION OF FOOD

Larvae of beetles and moths and grain mites can infest stored grain or birdseed. Some insects lay their eggs in the grains in the field and therefore are present as eggs in seeds and even flour. The heat associated with processing the grains usually eliminates the eggs from pellitized and extruded products. Many of these insects can crawl down the threads of an ordinary screw-cap jar, or penetrate a single paper or cloth bag, so it is necessary to use a glass jar with a rubber gasket or containers with tight-fitting lids to exclude them. For storage, bulk seed should be divided into 5- and 10-lb. containers so only small amounts will be lost if some of it becomes contaminated. One solution is to use 5-gallon buckets of the type used by bakeries. These buckets usually have tight-fitting plastic or metal lids.[13] Food should be stored in a cool and dry environment. Most pests will not infest products if the humidity is below 6%.[13] An inexpensive instrument can measure the humidity in the storage area. Alternatively, grain and seeds can be stored in the freezer. Food spills should be promptly cleaned up.

Preventing Indoor Access

At the time of purchase and/or when they are first brought into the home, foodstuffs should be inspected for possible mite infestation in the form of web-like structures on or around the material.[13]

Changing Habitat

Bacillus thuringiensis (*B.t.*) is a commercially available bacterial species that causes disease in certain insects by acting as a stomach poison. *B.t.* can be applied to stored grains for protection against the larval form of the Indianmeal moth. These insects seldom feed below a surface layer more than 4 inches deep in a grain bin, so *B.t.* can be effective if applied to the surface.[13] See Low-Risk Agents below.

Parasitoids such as the tiny *Trichogramma* can kill the egg stages of the moth. This approach could be very helpful for controlling long-standing infestations in the home or aviary that have proved resistant to the normal physical or sanitary methods already described.[13]

All stages of the Indianmeal moth are killed by freezing at 0° F (-17° C) for 4 days. A pheromone trap for monitoring is commercially available. Once infestation is found, the material can either be placed in a freezer or heated to kill pests. The material should then be discarded. Seriously infested products with webs are often secondarily contaminated with toxic levels of molds. Therefore, they should not be fed after freezing or heating.

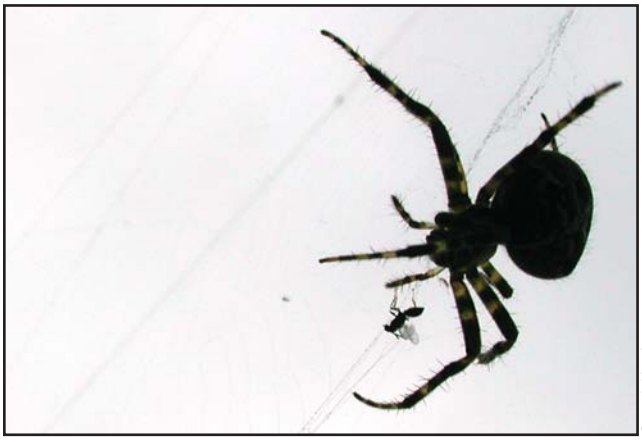

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Fig 11.4 | Spiders are often misunderstood and killed. Moving them, removing their webs and reducing the insect attractions that cause spiders to be attracted contributes to insect control in the long run.

CLOTHES MOTHS

The larvae of clothes moths attack various types of household material including blankets, upholstery and carpets. Clothes moth larvae avoid light and require material stained with food or sweat to provide the proper nutrients to grow. These moths do not attack clean clothes or fabrics stored in sealed containers. Carcasses of dead mice in wall voids can attract moths. Unoccupied bird or bat nests in attics can be a source of clothes moths and other insects.

Infestation by clothes moths can be managed chiefly by prevention. Clothes should be thoroughly cleaned before storing in tight containers. Vacuuming around the home and furniture is a way of controlling moths. Exposure to heat is a direct way to kill clothes moths. If the temperature can be maintained at or above 100° F (37° C) for several hours to days, all stages of the insect can be killed. Attics can often reach such temperatures in the summer. Extremely cold temperatures (sealed bags in a freezer) for several days also can control clothes moths. Traps to monitor for the presence of clothes moths can be hung in the closet as an early warning device.[13]

YELLOW JACKETS

Yellow jackets are a form of wasp that usually nest in the ground, but they can at times nest in walls of homes. Indoors they can actually excavate through plaster and in rare cases penetrate into adjacent rooms. Professional control using low-risk methods and performed at night to minimize disturbing the insects can be effective. When proper precautions are taken so as to not endanger residents, injecting a spray of pyrethrins and diatomaceous earth and then closing the access to the outdoors can be effective in eliminating the colony from a wall void. See also Traps to follow.

SPIDERS

The presence of spiders can indicate that there are flies in the house. Spiders are useful and should be removed to outdoors whenever possible (Fig 11.4). Spiders can be removed to the outside mechanically with a glass and a piece of stiff cardboard or by using a vacuum that will usually kill most spiders. Once the flies have been controlled and the spiders removed mechanically or by vacuum, they can be kept out by the same exclusion methods as those used for cockroaches and ants, and by caulking and using screens and door sweeps. There is usually no need to use a chemical spray.

MICE

Adult house mice can weigh from 0.5 to 1.0 oz (15 to 30 g). House mice breed year-round under optimum indoor conditions. Outdoors, these mice are seasonal breeders in the spring and fall. They are active primarily at night but also can be seen moving about during the day. Mice thoroughly investigate any change in their territory.[4] They can squeeze through openings slightly more than one-quarter inch in diameter. They prefer cereals to other food items. Management and prevention of infestations by house mice is a three-part process: mouse-proofing, sanitation and population reduction indoors with traps. When a mouse population already exists, some kind of lethal control is necessary. Otherwise, the reproductive capability of the mice and their remarkable ability to find food in almost any habitat will keep their populations steady or increasing.[4] The practice of using poisons on mice may lead to dead mice in wall voids, resulting in a moth infestation that can spread to clothing. Clothes moths are often attracted to the carcasses of dead animals. Other insects and bacteria can result from poisoned, decomposing mice; and pets, including pet birds, can be at risk from feeding on the dead mice or the rodenticide used for rodent control.

Preventing Indoor Access

Mice are found around human housing, especially in rural habitats. During the autumn and winter, they readily move into buildings that are not made rodent-proof. All holes must be sealed to limit the movement of mice into and through a building. Holes in foundation walls for pipes, utility lines and vents should be plugged with quarter-inch hardware cloth, copper mesh or steel wool.[4] Doors and windows should fit tightly and be caulked if necessary.

Preventing Food Access

Practicing good sanitation is a way to reduce the food supply. It enhances the effectiveness of traps and makes detection of a mouse infestation easier. Bulk foods should be stored in mouse-proof containers or rooms. Stored materials should be kept away from walls and off the floor.

If corn gluten herbicide is being used, it should be stored over the winter in a container that mice cannot penetrate. Any birdseed should be stored in tight containers or kept under refrigeration.

Changing Habitat — Indoors

Types of Traps

When used correctly, snap traps are very effective for controlling mice. Traps must be set in the right places, in high numbers and in the right position (see below) or mice will avoid them.[4] If used properly, snap traps inflict less suffering than do glue traps and possibly the so-called humane box traps, since if animals are released in a distant territory they will likely be attacked as aliens by resident mice.

Setting Traps

The territory of mice rarely extends farther than 30 feet from the nest, and more often is about 10 feet. If mice are sighted throughout a building it usually means there are numerous locations where traps should be set. Traps should be placed wherever there are obvious signs of mice. Probably the biggest mistake made when trapping mice is not using enough traps.[4] Traps should be set every 3 to 6 feet in prime mouse habitat. They should be set in a three-dimensional sphere about 10 feet in diameter around the signs.

Baits

Choosing good baits for mice and rats increases the effectiveness of mousetraps. Peanut butter (the chunky kind) is considered one of the best baits; food baits should be fresh to be effective. A cotton ball, which females like to use for nest material, also can be used. The cotton should be tied securely to the trigger.

Outdoor Low-Risk Pest Management

WEED MANAGEMENT

Synthetic chemical pesticides do not need to be routinely used against most types of weeds.[11] For poison ivy, digging out the root and/or applying a 9% solution of vinegar (used for pickling) are effective. For other broadleaf weeds, corn gluten meal (Fig 11.5) is an effective pre-emergent herbicide and can be used in spring and fall. Herbicidal soap is available for spot-treating weeds. On paved surfaces, boiling water, steam, a flamer or other heat source can be used to remove unwanted vegetation.

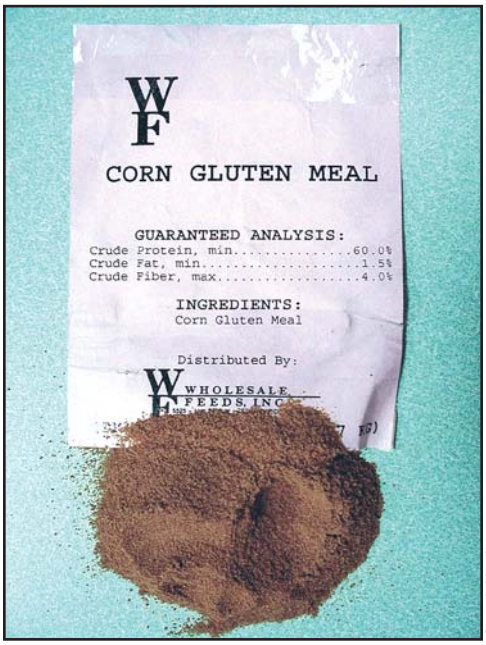

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Fig 11.5 | Corn gluten meal serves as a pre-emergence herbicide and then deteriorates into a soil nutrient supply source.

INSECT PESTS OF THE LAWN AND GARDEN

In many instances, the need for chemical insecticides can be replaced with management strategies and natural enemies of pests. Biological controls are commercially available. Beneficial insects also can be encouraged by providing certain plants in the garden needed by the insects for stages of their life cycles when they are not preying on pests (see Table 11.1 for RCC Web site for further details and information on grubs in the lawn; see also reference 16 and Suggested Reading "If You Plant It They Will Come").

MOSQUITOES

Mosquito Management

In most naturally occurring streams or even backyard ponds, living organisms such as fish, amphibians and insects feed on mosquito larvae and prevent the emergence of adults. Biological control of adults includes birds and bats.[3] In artificially occurring standing water, the mechanical emptying of containers every 4 to 5 days is the best prevention for adult mosquito emergence. When water cannot be changed due to high volume and/or there is not a system with naturally occurring biological controls, *B.t.* preparations (see below) can be used to kill off the developing mosquito larvae in standing water, as will dish soap or a thin coating of olive oil.

It is most important to clean out rain gutters so that they empty freely after a storm. Habitat should be provided for wildlife such as birds, bats and dragonflies (Figs 11.6, 11.7) that act as biological controls by consuming adult mosquitoes. For special outdoor occasions, there are mosquito-trapping devices[b], some quite successful, that generate carbon dioxide, heat and synthetic attractants.


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Fig 11.6 | The beneficial dragonfly acts as flying insect control by consuming large numbers of pest insects.


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Fig 11.7 | Swarms of dragonflies are seen seasonally during the height of the pest insect season.

Effective natural mosquito repellents include garlic oil, catnip and botanicals such as mint, citronella, geraniol, linalool, elemol (from the Osage orange tree), etc, used singly or in combination. There also is the synthetic chemical repellent DEET (best used at 30% concentration or less, applied to clothing, not to skin).

Mosquito repellent products can be sorted into three categories according to where they are applied: those placed on the clothing or skin; those dispersed into the air near people by a battery-powered device; and those applied to the ground area-wide, as granules or liquid or as liquid sprayed at ground level. More research is needed on the effectiveness of repellents in various delivery systems, even for active ingredients of the natural, non-synthetic type. The area repellent products require more research into their potential environmental hazards. Could they, for example, adversely affect beneficial insects and other life forms? See Garlic Juice Products below.

Low-Risk Agents

BACILLUS THURINGIENSIS (B.t.)

B.t is a spore-forming bacteria named for a town in Germany. Its insecticidal properties were first found in 1911 in diseased flour moths. *B.t.* contains a protein (endotoxin) that is toxic for many caterpillars and other insect larvae. Varieties have been discovered that affect a relatively narrow range of hosts, specifically mosquitoes, as well as certain moths and beetles. *B.t.* products in general lack toxicity for non-target species and the natural insect enemies of pests. *B.t* has been granted an exemption from establishing a tolerance for use on food crops due to its low toxicity for humans when taken by mouth.[13]

However, spray preparations of *B.t.* products have apparently been associated with adverse reactions when inhaled by certain sensitive individuals. Although in most cases *B.t.*would not be recommended for home use indoors against moth infestation, it is available commercially for that situation as well as for outdoor use against mosquito larvae, gypsy moth larvae and other garden pests.[13] *B.t.* preparations used for mosquito control include dunks and granules intended for use in standing water.

BORIC ACID

Boric acid is a crystalline material derived from borax, (a combination of sodium, boron and oxygen mined from the earth). It acts as a stomach poison when ingested by the cockroach or ant causing the insect to starve, which can take 5 to 10 days. It can be toxic to mammals when ingested in high doses. Boric acid does not represent a volatile danger in its powder form. It is considered "virtually vaporless."[13] It must be kept away from food, children and pets including pet birds to prevent oral consumption. Those applying boric acid powder should wear a dust mask, gloves, long sleeves and eye protection. It is considered a low-risk alternative when used indoors and placed in areas not accessible to pets or people, provided that precautions are taken and/or the formulation does not include another active ingredient or inert component that may volatilize and induce adverse effects through inhalation or dermal contact. If boric acid is applied to cracks, crevices and wall voids, the areas should subsequently be sealed by caulking or closed off by another means so that it will not present a problem to non-target individuals.[13] Boric acid remains active for months and cockroaches appear not to have developed any resistance after 50 years of use. Boric acid can be toxic under conditions of high exposure, so it is important to limit access.

CORN GLUTEN MEAL

The pre-emergent weed suppression qualities of corn gluten meal (CGM) were discovered in 1987. CGM, a waste product of corn milling that has been used in animal feed, is 60% protein and 10% nitrogen by weight. Protein is the active ingredient in CGM. It inhibits the growth of roots at the time of a plant's germination.

Timing of the application of this pre-emergent herbicide is very important. The precise moment in the year most advantageous for CGM weed control varies with growing conditions. The local cooperative extension service can be very helpful with advice on when best to apply CGM. For example, in the Northeast, to manage crabgrass in a lawn situation in the spring, CGM should be applied at the time of the crocus bloom and before the forsythia bloom takes place. If applied later, after the weeds have already germinated, the nitrogen in CGM could help the emerging weeds thrive (M. Talbot, personal communication, 2004). See Table 11.1 for Gardens Alive!, a resource for CGM. The use of CGM as an herbicide is patented by Iowa State University.

DIATOMACEOUS EARTH

Diatomaceous earth is obtained from the fossilized silica shell remains of diatoms, marine plankton. It has abrasive, sorptive and desiccant properties. It can be used alone or in conjunction with boric acid and/or pyrethrins (naturally occurring pesticides from chrysanthemums — see below). As with any dust preparation, a mask, goggles and gloves should be worn by the applicator to protect the eyes, respiratory system and skin.[13]

NEMATODES

Nematodes are tiny worms. Most species live in the soil and a few species are internal parasites of higher organisms including man. When fleas are replicating outdoors, certain species of nematodes may be effective in inhibiting their development[a].

PARASITOIDS

See Clothes Moths.

PYRETHRINS

Pyrethrins are short-lived biological pesticides isolated from chrysanthemums. They act as neurotoxic agents and have the ability to paralyze insects. They can be used in conjunction with diatomaceous earth or silica aerogel (see below). They are usually formulated with the agent piperonyl butoxide to prevent metabolism of the pyrethrin. Untoward allergic-type reactions in people or pets may take place when pyrethrins are used. Pyrethrins have very low acute toxicity for most


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Fig 11.8 | Leaf mold on this sea grape plant is a result of mites and the soil in the pot is not supporting healthy plant growth. Repotting and an application of liquid dish soap are considered an effective control.

mammals and birds, but they are highly toxic to fish.[2]

SILICA AEROGEL

Silica aerogel is an amorphous, non-abrasive, chemically inert, dust-like material. It results from the reaction of sodium silicate and sulfuric acid. Silica aerogels can absorb water and oil. When used as insecticide, it is believed to absorb the waxy protective coating on an insect's cuticle — an action that can result in dehydration and death of the insect. Silica aerogel particles are capable of irritating human lungs and eyes, so a dust mask, goggles and gloves should be worn during application.[13]

SOAPY WATER

A soap solution reduces the surface tension of water; as a result, insects are unable to float and they drown. Some plant pests are deterred by the use of soapy water applications (Fig 11.8). (See Ants - Preventing Access to Food).

GARLIC JUICE PRODUCTS

Neither the author nor the editors have any experience with garlic products. A veterinarian in the Netherlands states that one product[c] is very effective in controlling mosquitoes in the yard (J. Hooimeijer, personal communication, 2003). The smell is a potential problem for people who are sensitive to garlic. Originally garlic was developed for control of pest insects on organic vegetable crops. The farmers using the product found mosquitoes were no longer a problem in the fields for rather long periods of time after its use on vegetables.

TRAPS

A variety of traps are commercially available including the following:

- A yellow jacket outdoor trap for use away from the area where people are gathering, consisting of one-way ports and baited with cat food, sugar-containing cola drinks or meat. After yellow jackets enter the trap, placing the trap in the sun will kill them. This should be used only during the late summer when yellow jackets are aggressive toward people and their food. Traps can be purchased from local hardware stores.
- Ant and cockroach indoor traps have attractants and insecticides at sufficiently low concentrations for ants and cockroaches to carry the poison back to members of the colony without endangering other life forms.
- A mosquito outdoor trap[b] uses propane to generate carbon dioxide and heat. In addition, certain models may contain specific attractants such as octanol. These traps are designed to lure and kill only insects that seek a blood meal. They spare the non-biting forms.
- Moth traps use pheromones.

Products Mentioned in the Text

a. Scan Mask, Biologic Co, www.biologicco.com
b. Mosquito Magnet, www.mosquitomagnet.com
c. Garlic Spray, www.garlicbarrier.com/mosquitobarrier.html
d. Program - Lufenaron - Novartis

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Suggested Reading

1. **If You Plant It They Will Come**
   This brochure available from RCC lists vegetation designed to attract and nurture beneficial insects.
2. **Questionnaire for Interviewing Potential Pest Control Specialists**
   This handout available from RCC was designed to help individuals find pest control specialists that favor low risk methods of pest control.
3. **What's Wrong with My Bait?**
   This article from the BIRC publication Common Sense Pest Control provides hints on how to use baits safely and successfully. It is available from BIRC or RCC. See Table 11.1 for contact information.