

Pest Management in Feed Mills

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Pests

Invertebrate pests:



Stored-product insects

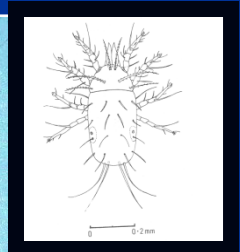
Filth flies



Cockroaches

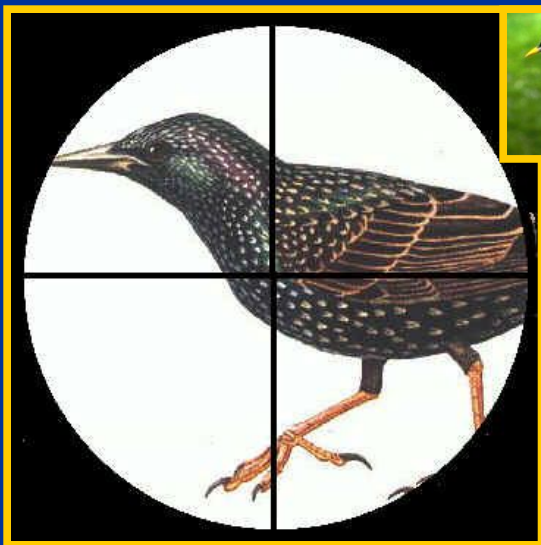


Mites



Vertebrate pests:

Birds



Rats and mice (rodents)



Economic Losses Caused by Pests

- ❖ Invertebrate pests cause 5-10% loss
- ❖ Vertebrate pests (rodents, birds) cause anywhere from 5 to more than 50% loss
- ❖ Loss characterization
 - ❖ Consumption of product
 - ❖ Quality loss (product adulteration)
 - ❖ Costs of sanitation
 - ❖ Repeated treatment costs
 - ❖ Product rejection by clients/customers
 - ❖ Loss of export markets

Stored-Product Insects

- ❖ Feed and reproduce on:
 - ❖ Stored grain
 - ❖ Milled products
 - ❖ Finished feed



Field



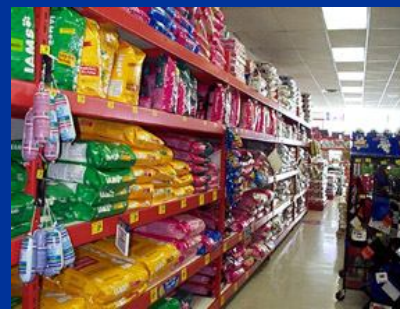
Farm



Transport



Processing plant



Retail store

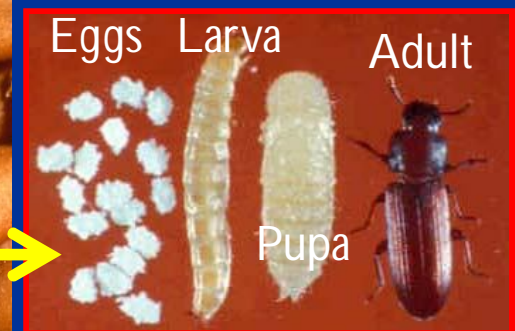
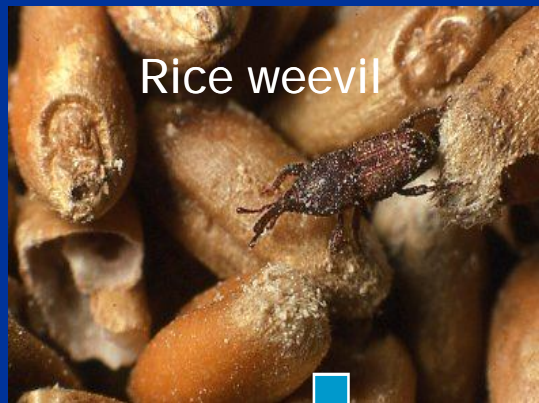


Consumer

Insects can infest grain and grain products from the farm to the consumer



Examples of Stored-Product Insects



Immature stages of weevil

- ❖ Live at 20-45°C and at 10-65% humidity
- ❖ Optimum, 28-32°C
- ❖ Egg-to-adult development, 30-40 days at optimum

Lesser Grain Borer Damage

100 adults left in grain for 7 days and then removed 30°C

0 days

28 days

56 days

76 days

106 days

128 days



Reproductive Potential of Stored-Product Insects

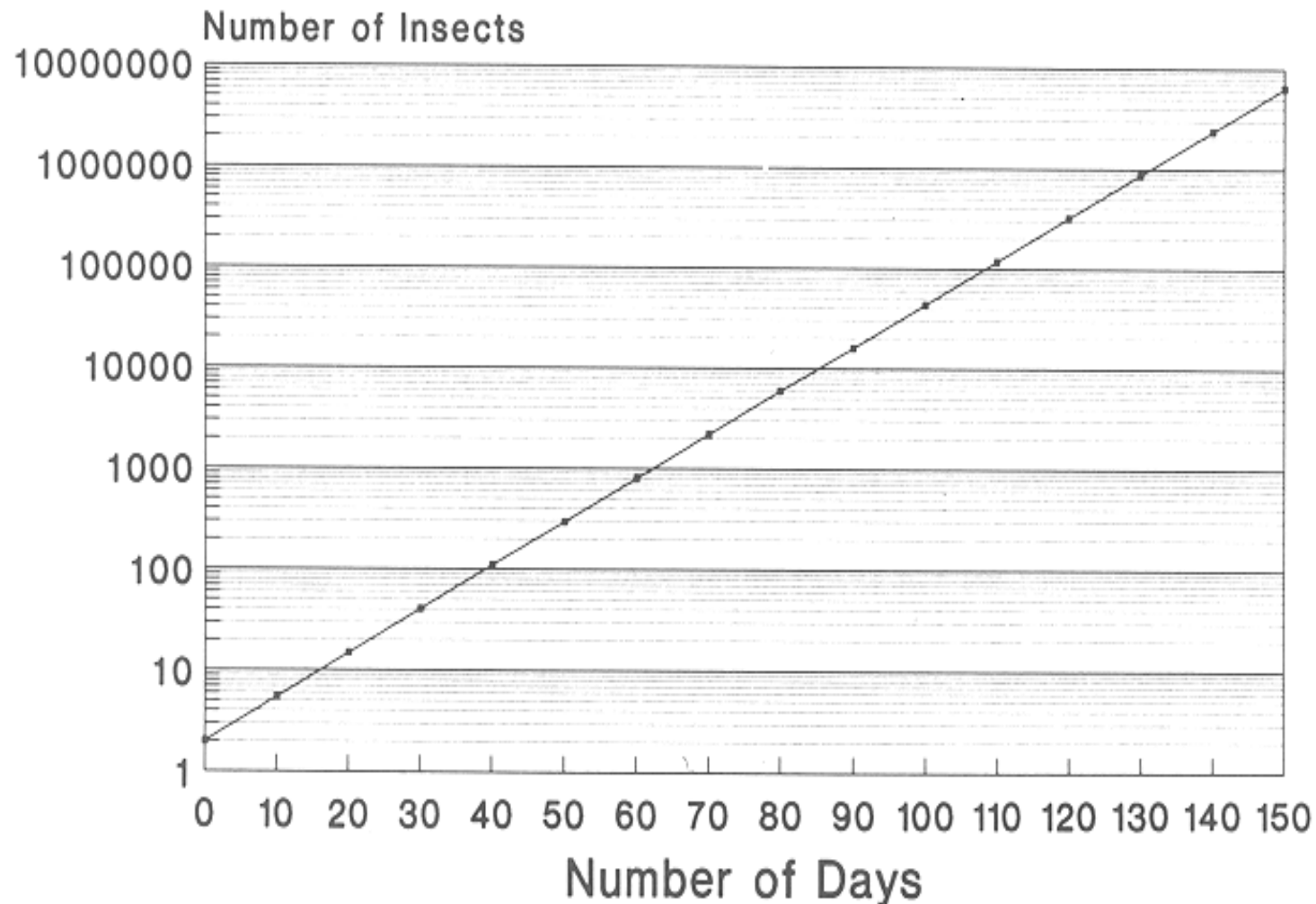


Fig. 3. The intrinsic rate of population increase for *Tribolium castaneum* at 28.5°C and 65% rh. (Data from Leslie and Park, 1949)

Insects in Feed Mills: Past Research

- ❖ **Rilett and Weigel (1956)**
 - ❖ 8 feed mills (11 mills total) in Buffalo, NY; 1954-55
 - ❖ Collected 23 species from product samples
- ❖ **Triplehorn (1965)**
 - ❖ 118 grain elevators and feed mills in Ohio; 1961
 - ❖ 44 species (21 families, 5 orders) from product samples
- ❖ **Loschiavo and Okumura (1979)**
 - ❖ 4 feed mills in Hawaii; 1976
 - ❖ 7 species from product samples and light traps
- ❖ **Pellitteri and Boush (1983)**
 - ❖ 20 feed mills in Wisconsin; 1975-76
 - ❖ Used product and trap samples; did not describe traps used
 - ❖ 18,410 total insects; 100 species (19 stored-product insects made up >83% of the total insects)

Survey of Insects in Eight Midwestern Feed Mills Larson et al. (2008)



- A total of 44,397 adults insects were captured
 - 30 species, 14 families, 2 orders
 - 27 beetle species, 3 moth species
 - 6 beetle species were non-stored product insects
 - Total captures by mill ranged from 48 (mill 6) to 16,638 (mill 1)

Mean No. Insects/Trap/Week: Mill Interior Captures

Time of year	Visit	Mill 1	Mill 3	Mill 5
Winter	1	3.8c	6.2d	7.1c
Spring	2	4.2c	48.2b	4.1c
Summer	3	101.4a	62.7a	40.1a
Fall	4	15.0b	11.5c	28.1b

Means within a mill followed by different letters are significantly ($P < 0.05$) different

Mean No. Insects/Trap/Week: Mill Exterior Captures (receiving, load out and perimeter)

Time of year	Visit	Mill 1	Mill 3	Mill 5
Winter	1	1.4b	0.0c	0.0c
Spring	2	1.7b	21.6b	2.1bc
Summer	3	204.3a	27.7a	19.3ab
Fall	4	212.3a	0.5c	19.5a

Means within a mill followed by different letters are significantly ($P < 0.05$) different

Unsanitary Conditions in Feed Mills



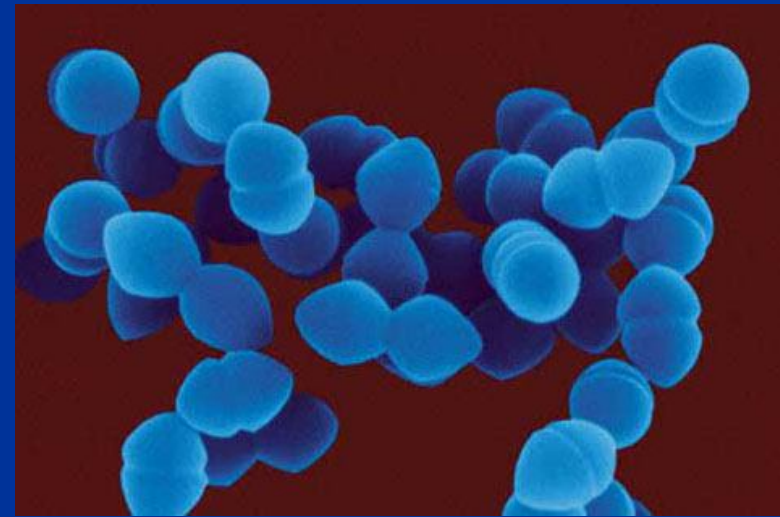
Association of Stored-Product Insects with Pathogens

- ❖ Stored-product insects are cosmopolitan in distribution causing significant damage to multi-billion dollar food industry
- ❖ Stored-product insects can survive in raw grains (stored on farms, feed mills, and flour mills) and processed food (feed and flour)
- ❖ Stored-product insects have been reported to harbor pathogens: *Salmonella* spp., *E. coli*, *Streptococcus* spp., *Enterococcus* spp. (Husted et al. 1969, Harein et al. 1970, De Las Casas et al. 1972, Larson et al. 2008)

Antibiotic Resistance Screening of Enterococcal species in Stored-Product Insects and Feed Mill Product Samples

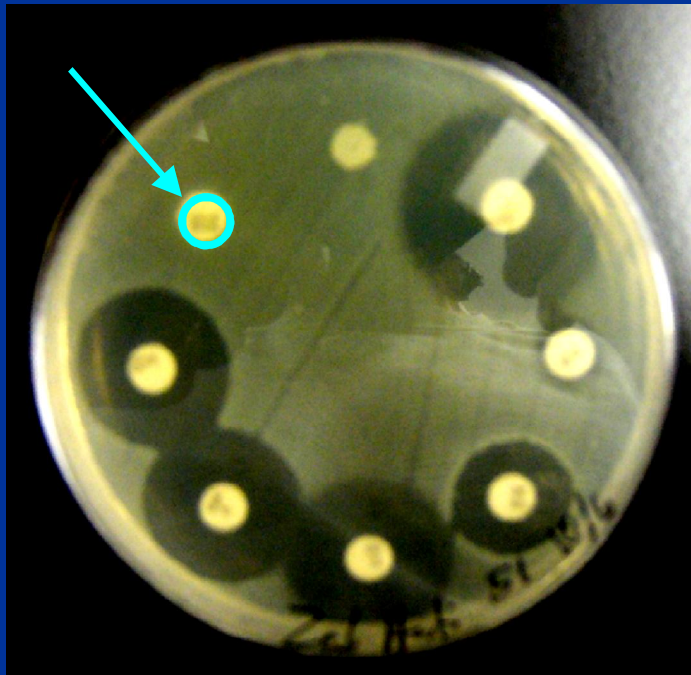
❖ Antibiotics

- ❖ Tetracycline 30 μ g (TET)
- ❖ Ampicillin 10 μ g (AMP)
- ❖ Erythromycin 15 μ g (ERY)
- ❖ Vancomycin 30 μ g (VAN)
- ❖ Chloramphenicol 30 μ g (CHL)
- ❖ Ciprofloxacin 5 μ g (CIP)
- ❖ Kanamycin 2000 μ g (KAN)
- ❖ Streptomycin 2000 μ g (STR)
- ❖ Gentamicin 120 μ g (GEN)



Lakshmikantha, HC and Bh Subramanyam
(2009, Unpublished data)

Measuring Antibiotic Resistance



Resistance is determined by the bacterial carpet growing up to the diffusion disk or a having small zone of inhibition



Susceptibility is determined by measuring the zone of inhibition (dotted line) created by the antibiotic around the disk

Incidence of Enterococci in Stored-Product Insects

Insect species	No. insects	No. insects positive for enterococci (%)	No. enterococcal isolates (%)
<i>Insects from feed mill</i>			
Confused flour beetle	70	30 (42.8)	39 (25.3)
Lesser meal worm	2	1 (50.0)	2 (1.3)
Rusty grain beetle	10	3 (30.0)	8 (5.2)
Small-eyed flour beetle	1	0 (0.0)	0 (0.0)
Lesser grain borer	8	4 (50.0)	8 (5.2)
Maize weevil	1	0 (0.0)	0 (0.0)
Drugstore beetle	7	3 (42.8)	9 (5.8)
Red flour beetle	75	34 (45.3)	44 (28.5)
The warehouse beetle	18	8 (44.4)	16 (10.4)
Foreign grain beetle	2	1 (50.0)	2 (1.3)

Source	Total insects	Prevalence (%)	No. enterococcal isolates	Mean ± SEM CFU/insect
Feed mill	194	90 (46.4)	129	3.8 ± 0.8 x 10 ¹

Prevalence of Enterococci in Feed Samples

Source	No. feed samples	Prevalence (%)	No. enterococcal isolates	Mean \pm SEM CFU/g
Swine farms ^a	41	24 (58.0)	160	$8.1 \pm 6.3 \times 10^3$
Feed mills ^b	48	16 (33.0)	48	$1.0 \pm 0.2 \times 10^1$
Total	89	40 (43.0)	208	$4.0 \pm 3.0 \times 10^3$

^aData based on 2 swine farms

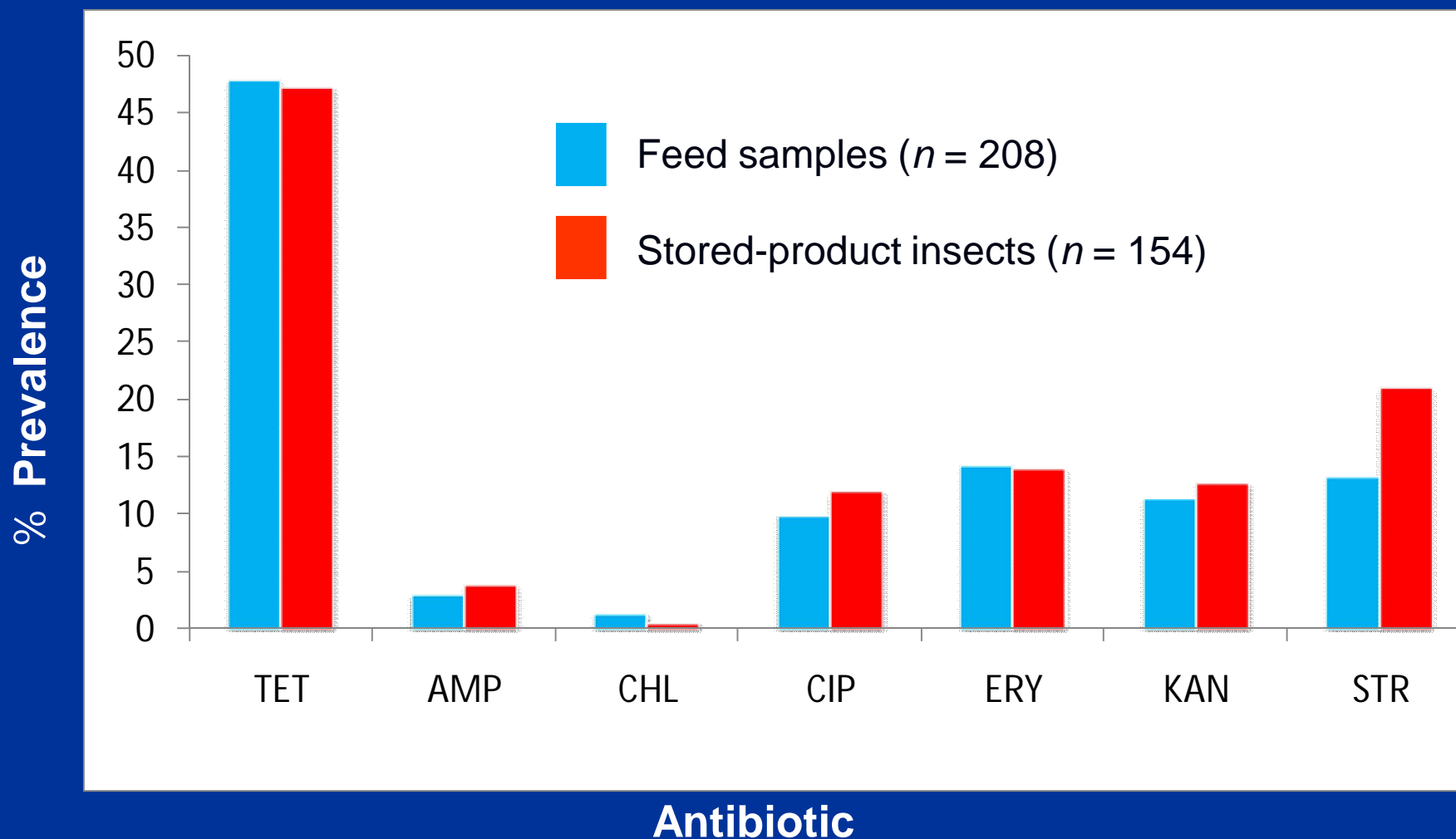
^bData based on 6 feed mills

Enterococcal Species Distribution

Source	Total isolates	Number of isolates (%)				
		<i>E. faecalis</i>	<i>E. faecium</i>	<i>E. gallinarum</i>	<i>E. casseliflavus</i>	<i>E. hirae</i>
Stored-product insects	154*	10 (6.5)	22 (14.3)	37 (24.0)	78 (50.6)	7 (4.5)
Feed samples	208	8 (4.0)	37 (18.0)	37 (17.0)	114 (55.0)	12 (5.0)
Total	362	18 (5.0)	59 (16.0)	74 (20.0)	192 (53.0)	19 (5.0)

*Also includes isolates from insects found in grain silo and retail store.

Antibiotic Resistance Profiles of Enterococci



None of the isolates was resistant to vancomycin and gentamicin

Survival of *E. faecalis* in Poultry Feed and its Acquisition and Transmission to Sterile Feed by *Tribolium castaneum* (red flour beetle) Adults^{a,b}

Days after Incubation	Poultry feed Mean \pm SEM / g	<i>T. castaneum</i> Mean \pm SEM / insect		Transmission of <i>E. faecalis</i> to sterile poultry feed by <i>T. castaneum</i> Mean \pm SEM / g
		Non-surface sterilized	Surface sterilized	
1	3.3 \pm 0.3 $\times 10^6$ a	3.9 \pm 0.6 $\times 10^4$ a	1.6 \pm 0.1 $\times 10^3$ a	3.3 \pm 0.3 $\times 10^3$ a
3	6.7 \pm 0.5 $\times 10^4$ b	4.8 \pm 0.2 $\times 10^3$ b	2.0 \pm 0.3 $\times 10^3$ a	1.6 \pm 0.3 $\times 10^3$ a
5	2.0 \pm 0.0 $\times 10^4$ c	1.5 \pm 0.4 $\times 10^3$ c	5.0 \pm 0.1 $\times 10^2$ b	6.0 \pm 0.3 $\times 10^2$ a
7	1.1 \pm 0.0 $\times 10^4$ d	1.3 \pm 0.2 $\times 10^3$ c	2.0 \pm 0.0 $\times 10^2$ b	3.0 \pm 0.3 $\times 10^2$ b

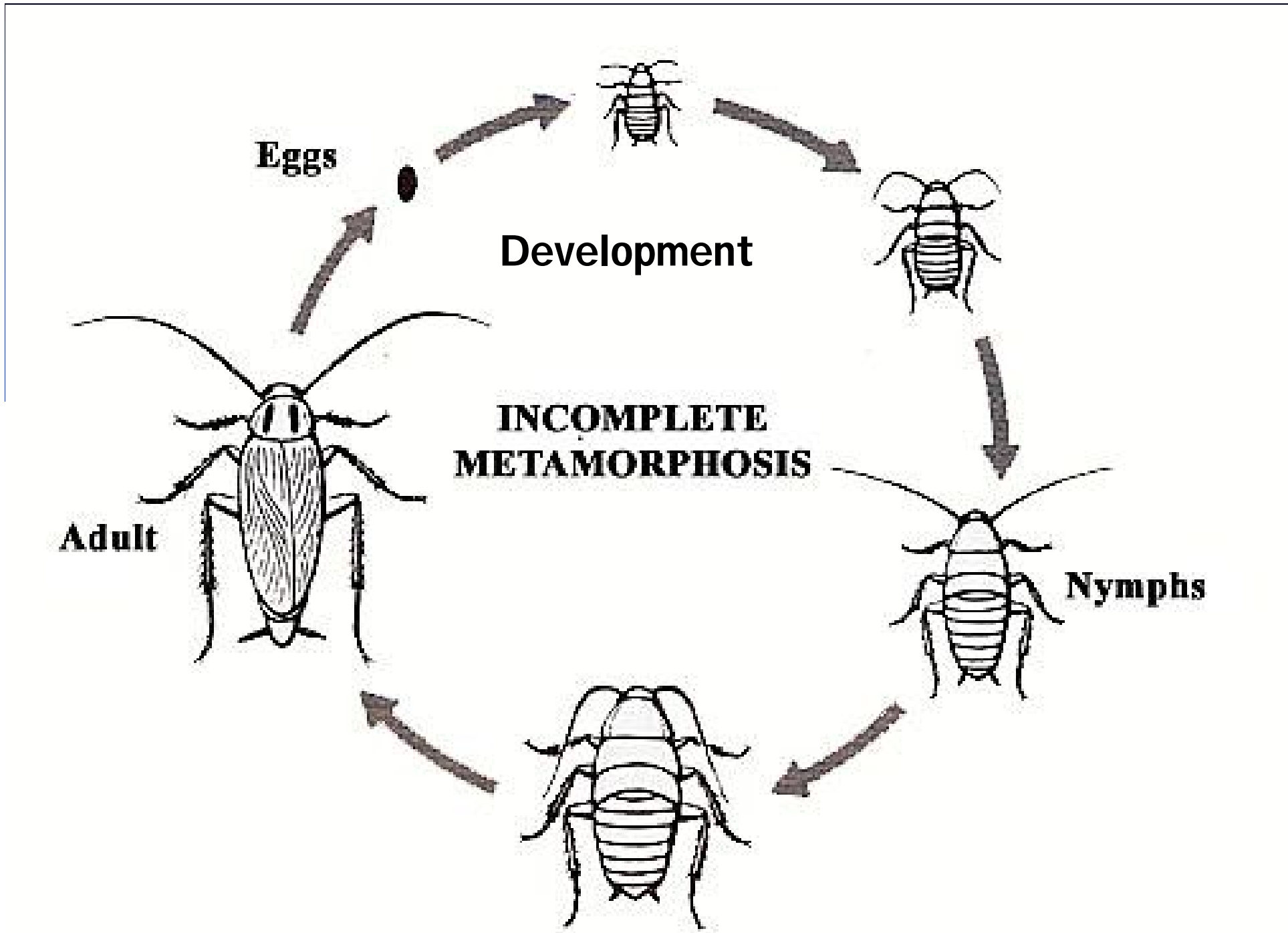
Initial *E. faecalis* concentration was $4.6 \pm 0.3 \times 10^6$

^aEach mean is based on $n = 3$ replications

^bMeans within a column followed by different letters are significantly different ($P < 0.05$; by Fisher's Protected LSD test)

Cockroaches and Public Health

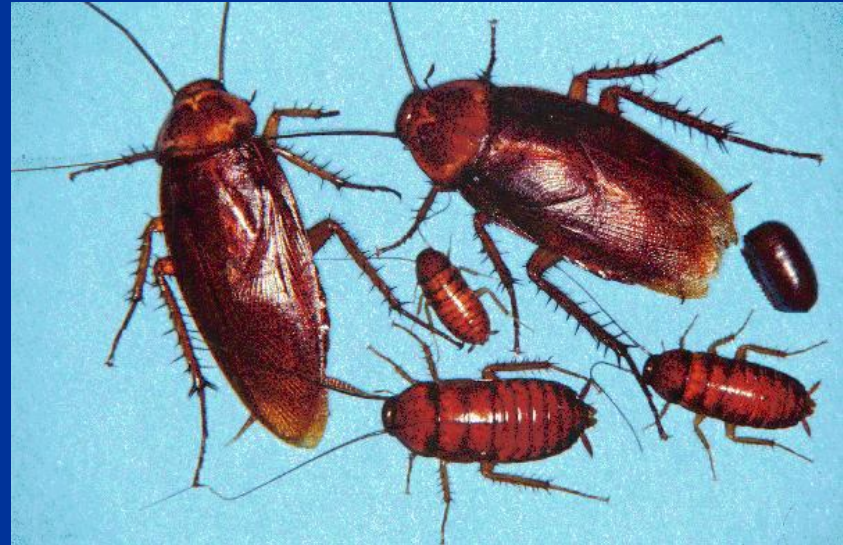
- ❖ Cast skins cause allergic reactions in sensitive individuals
- ❖ Transfer pathogens to food
- ❖ Body secretions may impart odor to food



German Cockroach



American Cockroach



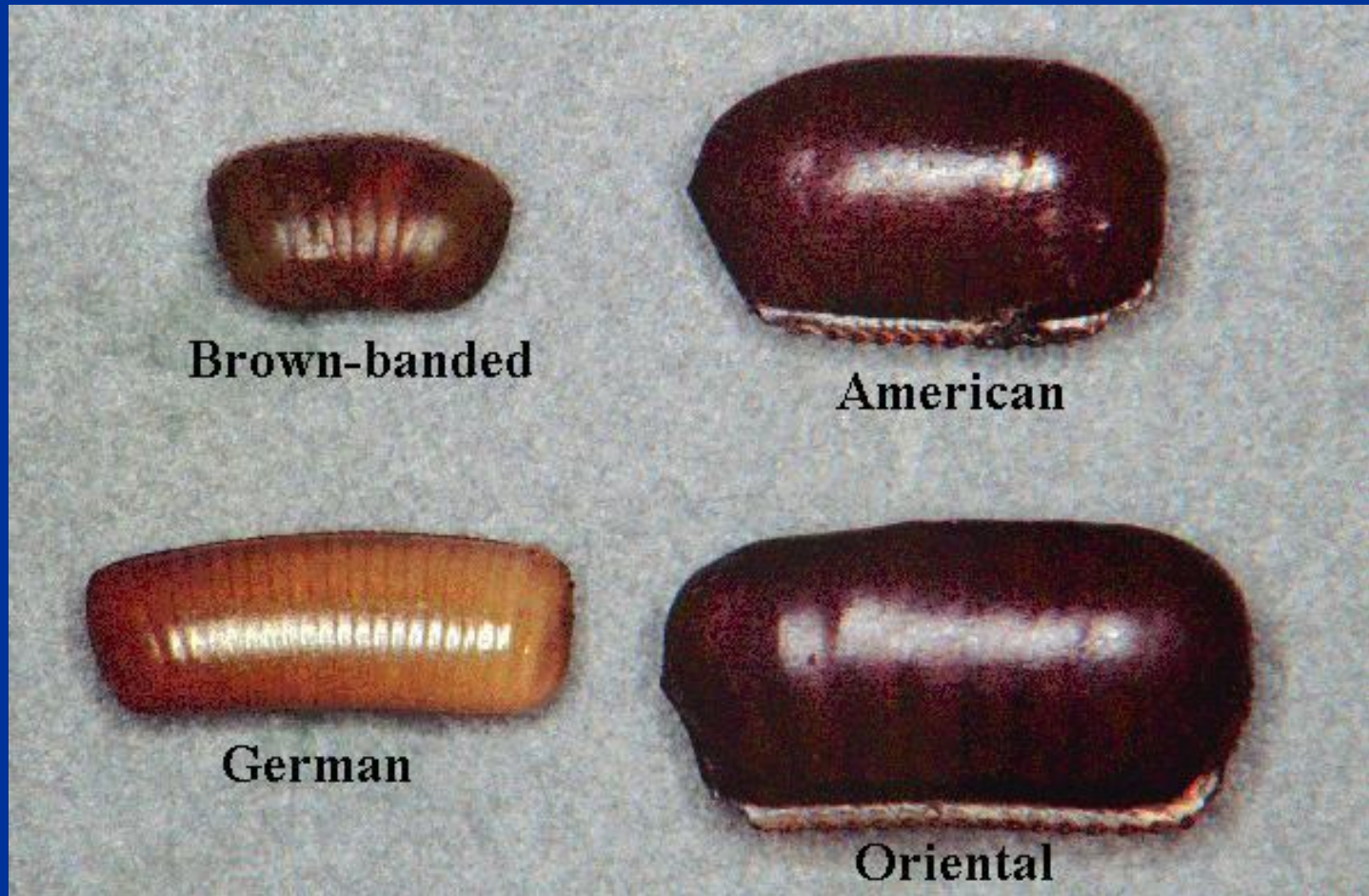
Oriental Cockroaches



Brown-banded Cockroach



Egg Cases (Ootheca) of Cockroaches



Biological Differences Among Cockroaches

Species	Eggs/ Case	Egg cases/ lifetime	Egg stage (days)	Nymphal stage (days)	Adult longevity (months)
German	30 - 48	4 - 8	21- 28	40 - 125	< 12
American	14 - 18	12 - 24	30 - 60	160 - 971	14 - 15
Oriental	14	6 - 8	40 - 60	120 - 365	> 12
Brown- banded	13 - 18	14	50 - 75	95 - 276	< 10

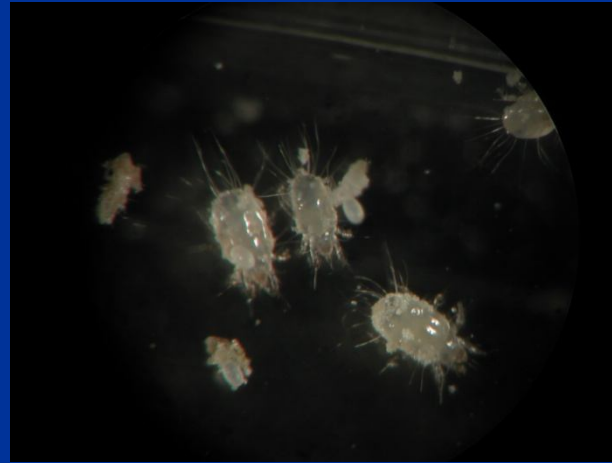
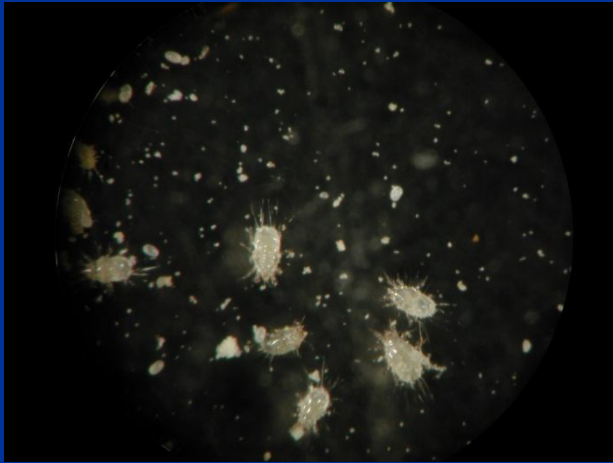
Flies



House Fly



Stored-Product Mites



- ❖ 8 legs (6 for insects)
- ❖ Develop at $\geq 9-35^{\circ}\text{C}$
- ❖ Egg-to-adult development in 2-3 weeks

- ❖ Thrive well in warm, humid climates ($>80\%$ RH)
- ❖ Common in feed mills



Rodents

Classification of Rodents

- ❖ Class: Mammalia
- ❖ Order: Rodentia
- ❖ Family: Muridae

- ❖ Order Rodentia has 1,700 species of rodents in 35 families
- ❖ Larger rodent is the Capybara of South America (50 kg: 110 lb)
- ❖ Smallest is the pygmy mouse (few grams)
- ❖ *Rodere* in Latin means "to gnaw"



www.irri.org/irrc/rodents/index.asp

Rats and Mice

- ❖ Family Muridae has 500 species
- ❖ Rats and mice of SE Asia include:
 - ❖ Rice field rat, *Rattus argentiventer*
 - ❖ The black rat, *Rattus rattus diardii*
 - ❖ The wood rat, *Rattus tiomanicus*
 - ❖ The Norway rat, *Rattus norvegicus*
 - ❖ Little Malay rat, *Rattus exulans*
 - ❖ Greater bandicoot rat, *Bandicota indica*
 - ❖ House mouse, *Mus musculus* (several subspecies)
- ❖ Pelage: Vibrissae (long stiff hairs). Guard hairs
 - ❖ Protect from cold; tactile feedback; wetness; defense

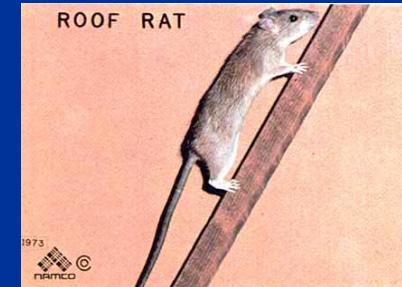
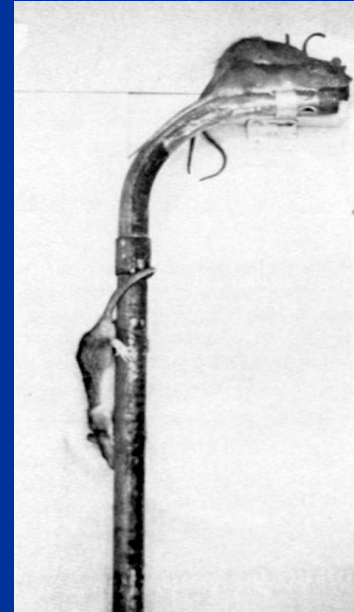


R. argentiventer (GR Singleton)



Features

- ❖ Nocturnal in habit
- ❖ Excellent swimmers
- ❖ Good climbers
- ❖ Good sense of smell and hearing
- ❖ Can gnaw through materials like lead sheathing, aluminum, wood, wiring, etc
- ❖ Can enter through very small openings
- ❖ Tail
 - ❖ Variable length, furry, scaly, or bare
 - ❖ Cools the animal
 - ❖ Prehensile
 - ❖ Provides balance



Senses

❖ Vision

- ❖ Colorblind
- ❖ Rely mostly on smell and touch
- ❖ Can identify objects up to 15 m (50 ft) away
- ❖ Can detect motion up to 10 m (33 ft)

❖ Touch

- ❖ Thigmophilic (Vibrissae)
- ❖ They prefer to squeeze between objects
- ❖ When foraging in open areas, they mark travel paths with pheromones

❖ Kinesthetics: memorization of muscular movements

❖ Olfaction: locate food, pathways, territories, and identify colony and non-colony members. Mark objects with urine and body secretions

❖ Taste: respond to sweet, bitter, salt, and sour. Can detect contaminants in food (as low as 250 ppb)

❖ Hearing: can hear 90 – 100 kHz range. Emit ultrasounds to communicate, locate objects, and assist in maneuvering

Reproductive Biology

- ❖ **High reproductive potential**
 - ❖ Rapid sexual maturity
 - ❖ Short gestation periods
 - ❖ Large litter sizes and numbers/litter
 - ❖ Year-round breeding
 - ❖ Life span: 4-6 months and as long as 18 months
- ❖ **Social structure and territories**
 - ❖ Marking pheromones
 - ❖ Territorial range is variable
 - ❖ Hierarchy-dominant male ("king rat")
- ❖ **Explorations:** neophilic as well as neophobic
- ❖ **Harborage selection:** in the ground, tree trunks, and any suitable hollow space. Helps in maintaining body warmth
- ❖ **Feeding behavior:** omnivorous



www.irri.org/irrc/rodents/index.asp

Pest Significance

- ❖ Absolute population density in a given habitat is unknown
- ❖ FAO, 1982 estimate: 42 millions tons of food worth \$30 billion
- ❖ Typically 1/5th of our food supply is consumed by rodents
- ❖ Food spoilage
- ❖ Rat can consume 30 g each evening; mice 2-4 g
- ❖ One mouse can excrete 40-100 fecal pellets and 100 droplets of urine per day. Rat 20-50 pellets and 14 ml (0.5 oz) of urine per day
- ❖ Zero threshold in food/feed plants
- ❖ **Gnawing damage:** 0.4 mm per day; 5.5 moh's; 500 kg per sq cm (7,000 psi); 6 bites per second
- ❖ **Burrowing damage:** damage insulation
- ❖ **Disease transmission:**
 - ❖ In the last century 10 million people have died from rodent-borne diseases
 - ❖ Implicated in 55 different diseases (Bacterial 20; Virus 17; Rickettsial 9; Protozoan 3; Cestodes 3; Nematodes 3; Trematodes 1)

Rodent Control Fights Hunger!

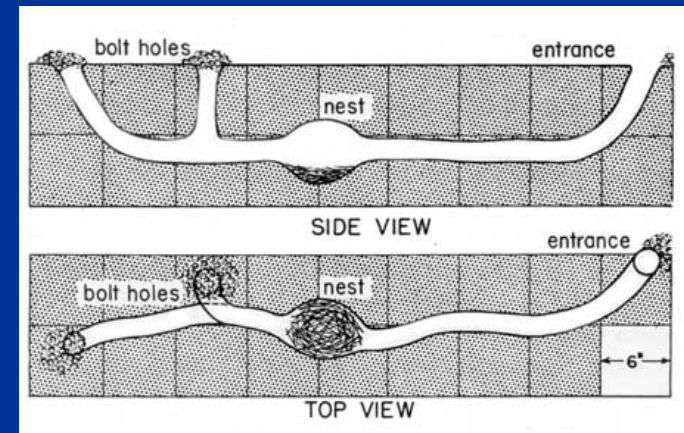
Continent	Production (Million tons)	Gained production (Million tons)	No. extra people nourished (Millions)	Percentage of Undernourished benefiting
Asia	1086.46	54.32	217.3	39
Latin America	156.70	7.74	31.3	60
Africa	113.66	5.68	22.7	11
Europe	37.70	1.89	7.5	26
Total (world)	1394.52	69.73	278.8	34

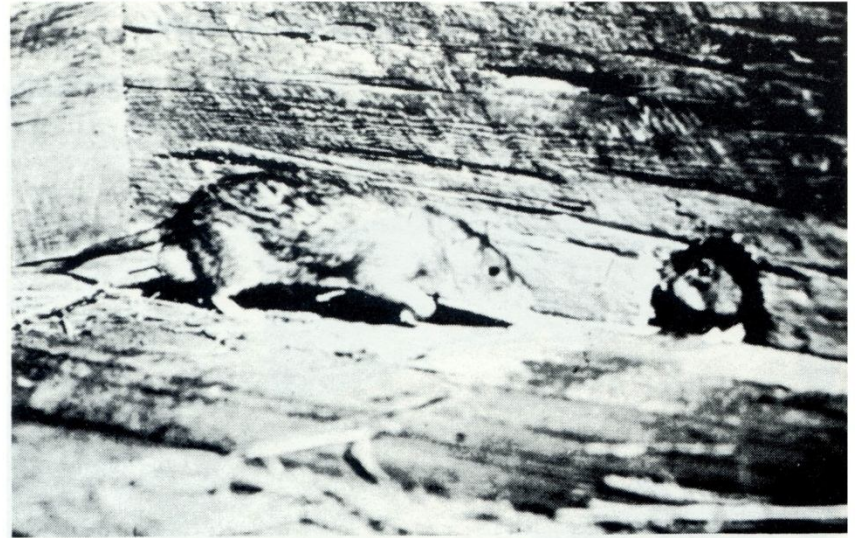
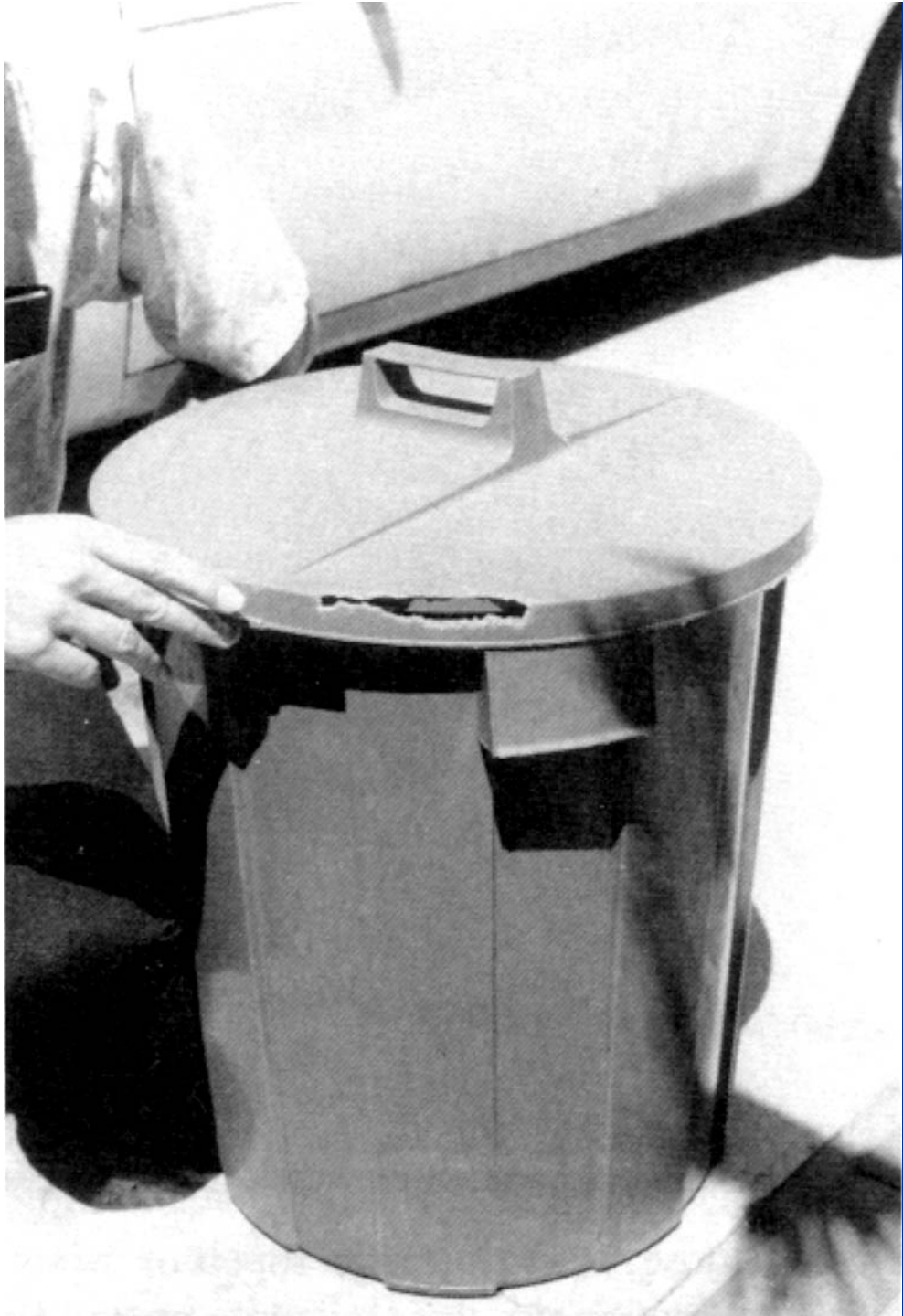
Includes all cereals in 113 countries where undernourishment exists.

Source: Meerburg, BG, GR Singleton, and H Leirs. 2009. The year of the rat ends—time to fight hunger! *Pest Manag. Sci.* 65: 351-352.

Signs of Rodent Infestation

- ❖ Rodent droppings and urine stains
- ❖ Rodent tracks
- ❖ Gnawing damage
- ❖ Burrows
- ❖ Runways
- ❖ Grease marks
- ❖ Rodent sounds and odors



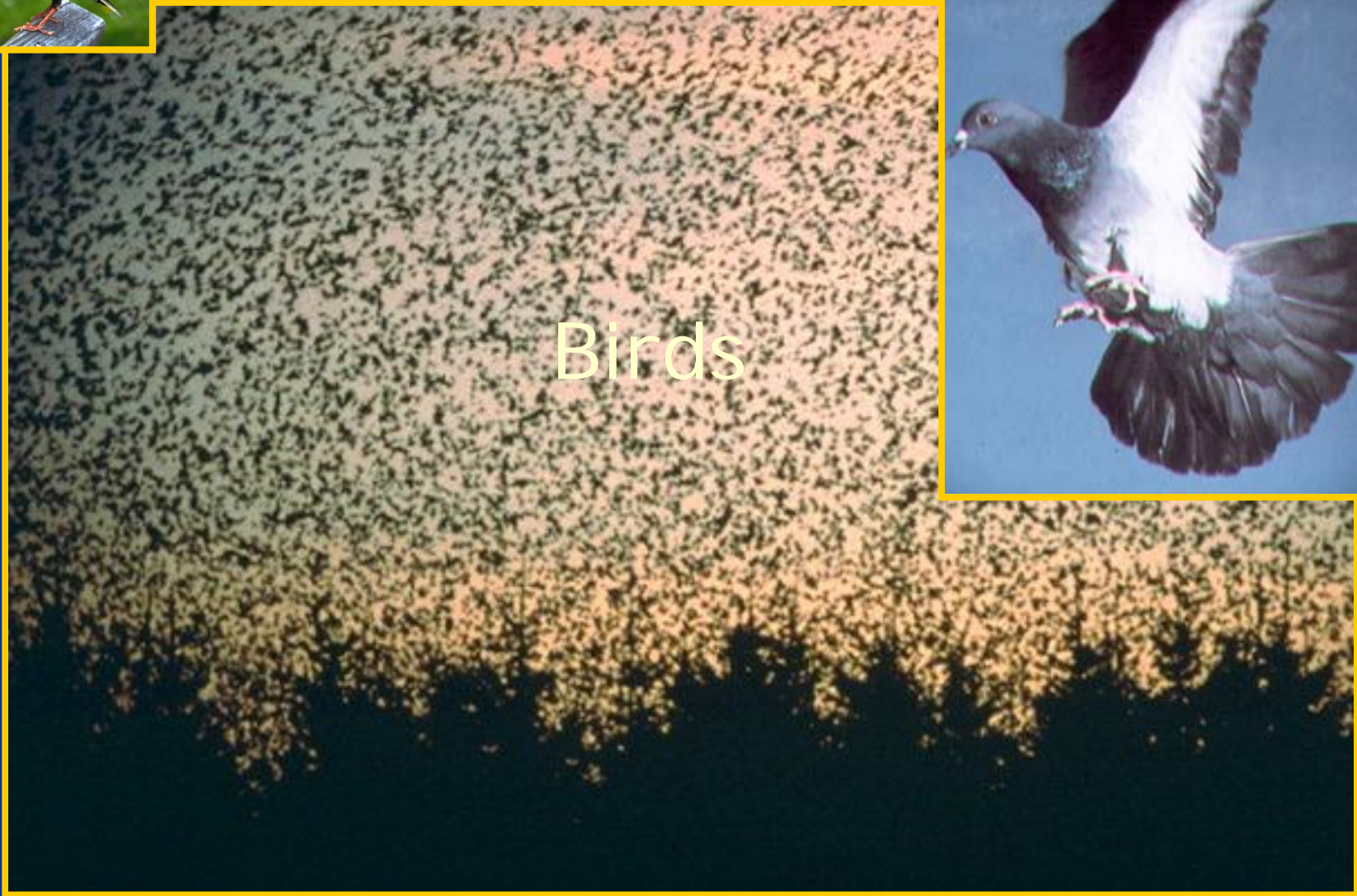


They Can Gnaw Through Wood Walls



Nesting material and rodent damage





Birds

Birds as Pests

- ❖ Subjective and based on perception
- ❖ Sensitive issue
- ❖ Anything out of place that interferes with human health is a pest
- ❖ Birds become pests when they enter food plants, roost near loading docks, build nests in drains/down spouts, defecate on doors/windows, loaf around air intake ducts
- ❖ Some birds are protected by federal, state, and local laws

Pest Birds

- ❖ Major – can be managed without permits
 - ❖ Pigeon – *Columba livia*
 - ❖ The house sparrow – *Passer domesticus*
 - ❖ The European starling – *Strunus vulgaris*
- ❖ Minor
 - ❖ Gulls – *Larus argentatus*
 - ❖ Crows – *Crovus brachyrhynchos*
 - ❖ “Blackbirds” – Several species
 - ❖ Grackles – *Quiscalus quiscala*
 - ❖ Woodpeckers – Several species
 - ❖ Cowbirds – *Molothrus ater*

Damage Caused by Birds

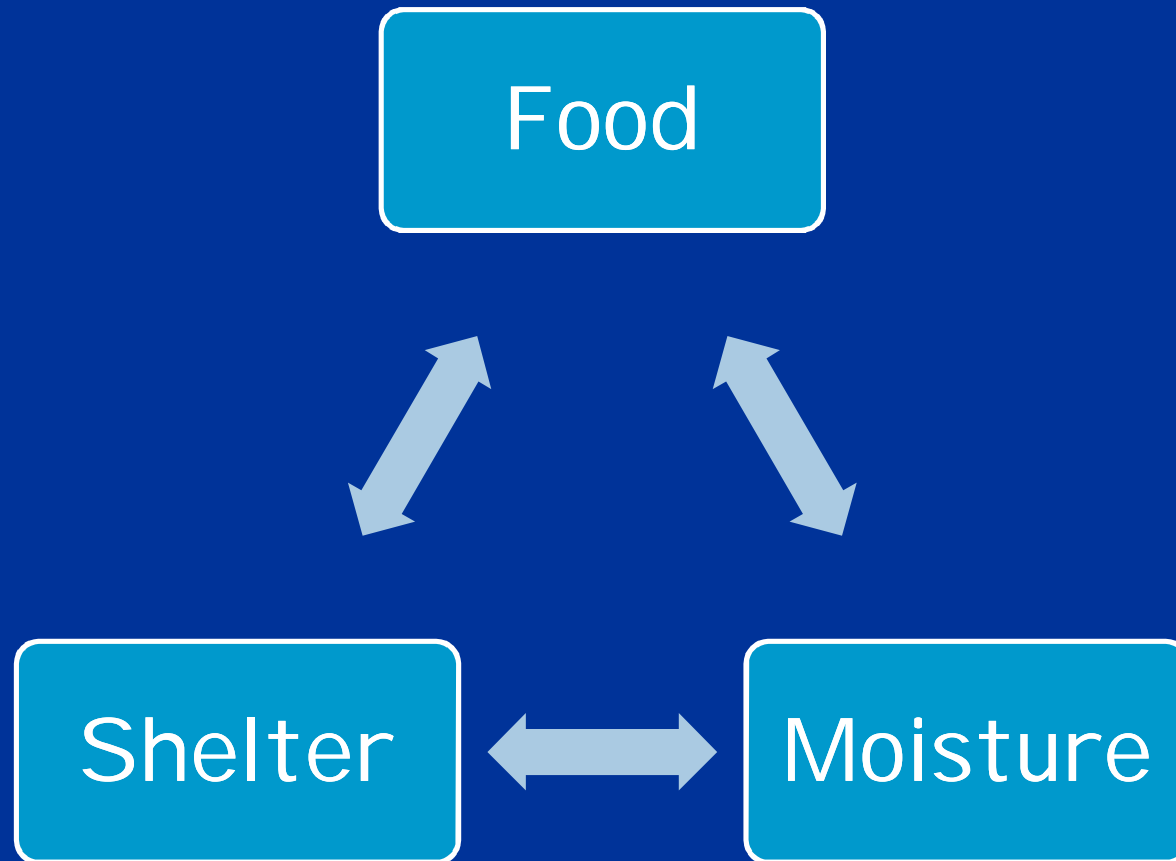
- ❖ Woodpeckers damage wooden structures
- ❖ Acidic feces are corrosive when moist
- ❖ Disintegrate tar-roofs, reduce roof's life expectancy
- ❖ Feces damage air conditioning equipment, siding, insulation, and machinery
- ❖ Feces create slippery conditions
- ❖ Bird nests can cause fires
- ❖ Blockage of ventilation systems
- ❖ Blockage of gutters resulting in roof collapse
- ❖ Risk to people working near areas contaminated with bird feces

Diseases and Parasites

- ❖ Moist feces support fungi and bacteria
 - ❖ Aspergillosis, Histoplasmosis
 - ❖ Psittacosis, Salmonellosis
- ❖ Birds carry ectoparasites
 - ❖ Chicken and Northern fowl mite
 - ❖ Fleas and ticks
- ❖ Birds are reservoirs for viral diseases transmitted to humans by mosquitoes
 - ❖ Eastern equine encephalitis
 - ❖ St. Louis encephalitis
 - ❖ Western equine encephalitis
 - ❖ Venezuelan encephalitis
 - ❖ West Nile fever
 - ❖ Birds are reservoirs for viral diseases transmitted to humans by mosquitoes



Why Are Pests Present?



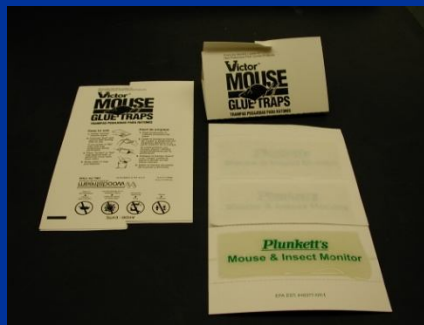
Integrated Pest Management (IPM)

- ❖ Concepts:
 - ❖ Manage pests below unacceptable levels
 - ❖ Use multiple tactics
 - ❖ Use pesticides only as a last resort
 - ❖ Prevent access to food, shelter, and moisture

First I nspect, Monitor, Assess, and Evaluate

- ❖ I nspection
 - ❖ Visual (part of GMPs)
 - ❖ I nbound and outbound material, mill interior and exterior
 - ❖ I dentifies source of pests, sanitation issues
- ❖ Monitoring
 - ❖ Traps and mechanical devices
- ❖ Assessing
 - ❖ Pest density and distribution
- ❖ Evaluation
 - ❖ I mplement tactics, evaluate impacts/benefits

Traps and Mechanical Devices



Prevent Access to Food

- ❖ Sanitation (cleaning practices)
- ❖ Create pest barriers
- ❖ Prevent pest entry points into the mill
- ❖ Store grains or finished feed properly
 - ❖ In cocoons
 - ❖ Admixture of chemicals
- ❖ Sanitary design of equipment to eliminate food within equipment
- ❖ Pest (insect) resistant packaging material for finished feed



Rate Mill Infestation By Location for Sanitation

Probability of infestation or product loss

Cleaning frequency

	High	Moderate	Low	Zero
Daily	Production Areas; receiving	Floors		
Weekly				
Monthly		Spouts; conditioner		Bathrooms
Yearly			Building exterior	

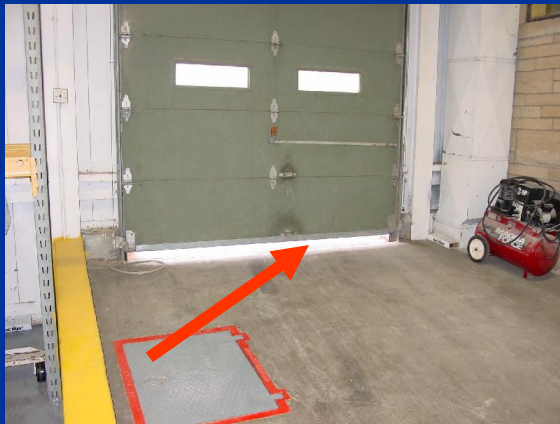
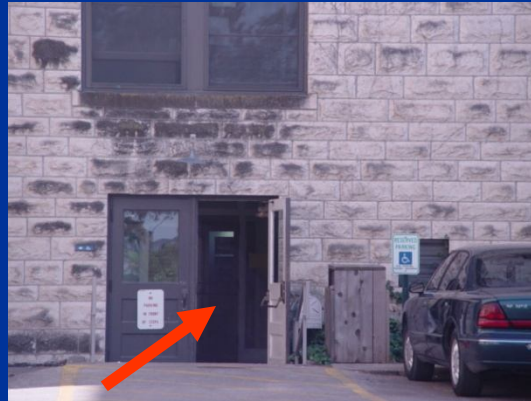
Remove Spillage

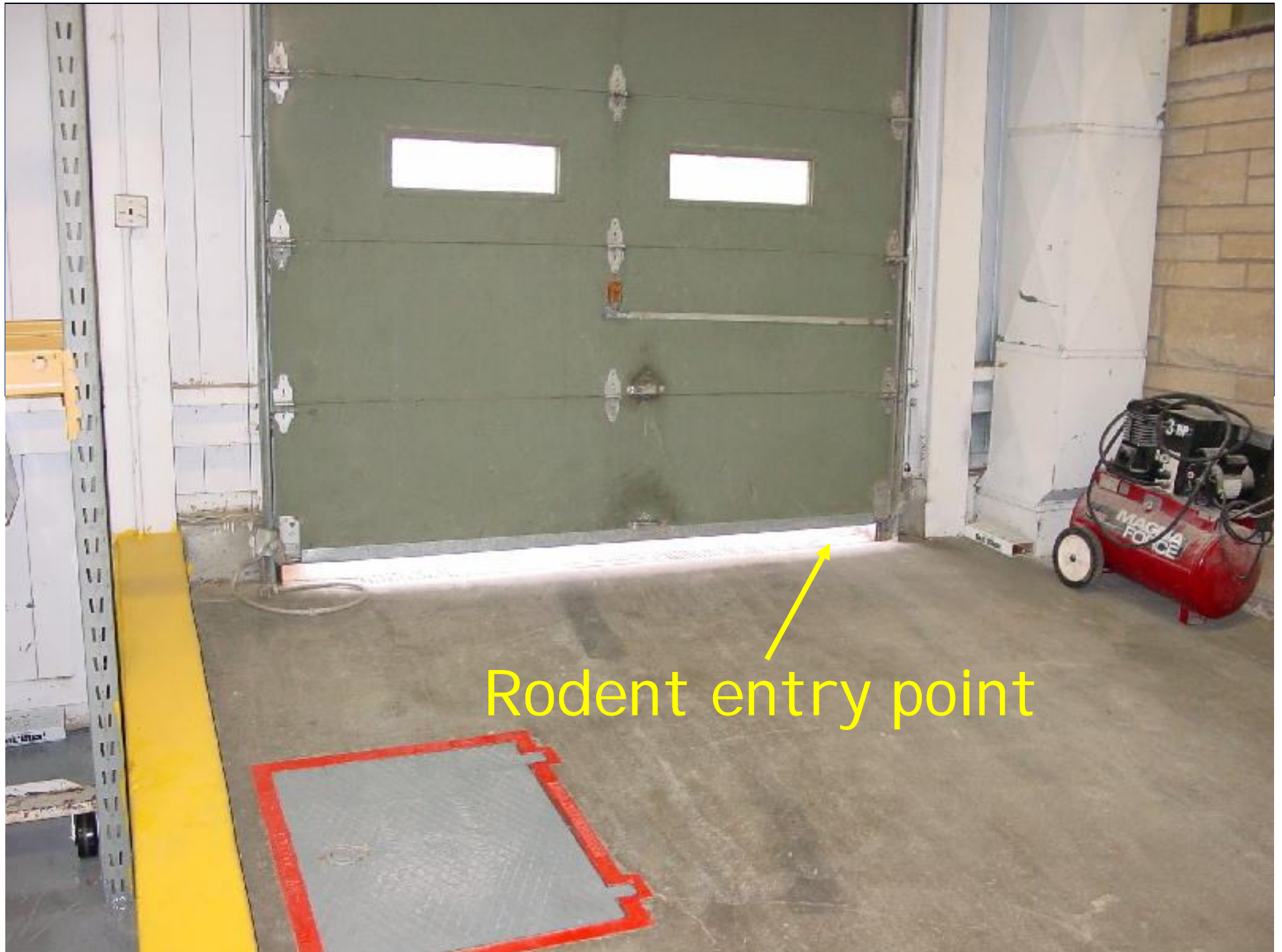


Avoid clutter:
Potential harborage sites for rodents/insects



Deny Pest Entry Into Your Mill

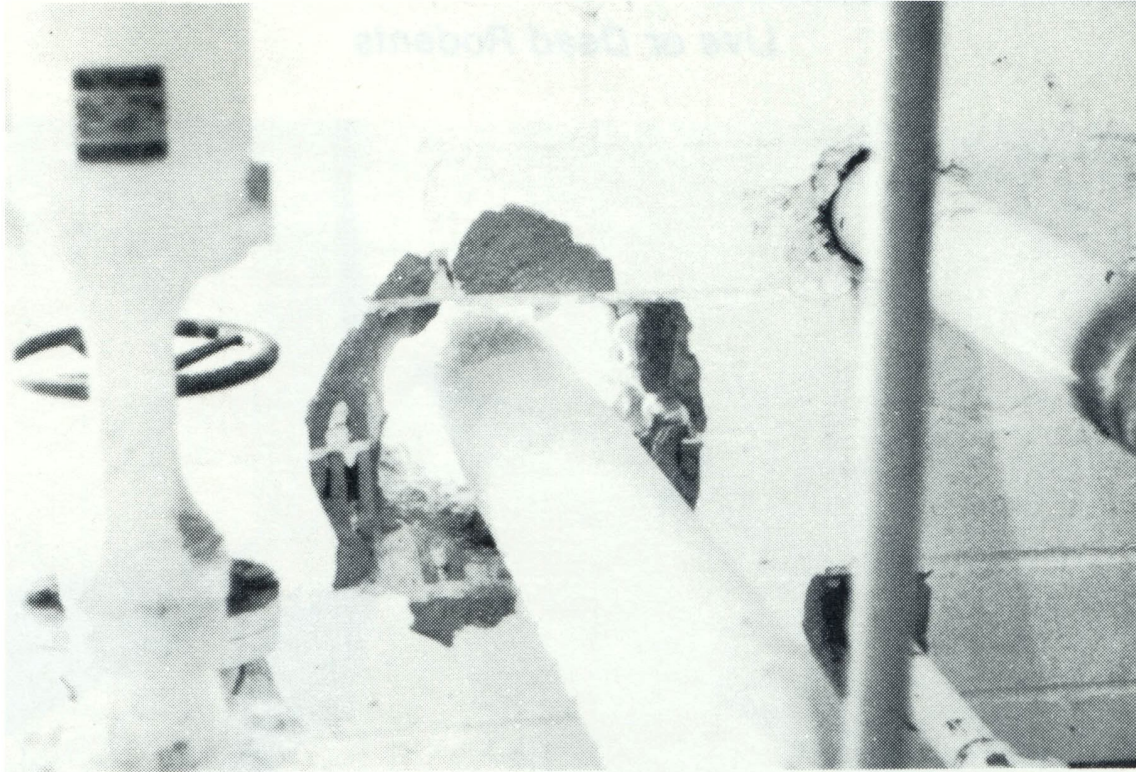




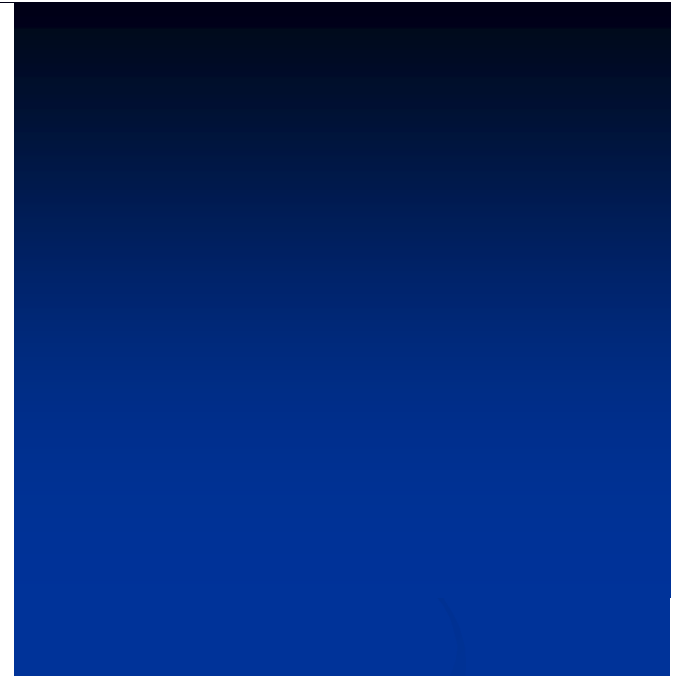
Rodent entry point



Poor door seal



Holes in the Wall



Exclusion Tactic for Rodents/Insects



Eliminate Flat Surfaces and Remove Unused Equipment

Flat surfaces



Storage of unused equipment



Trap Barrier System for Rodent Control in Southeast Asia



- ❖ 1 m high, bottom buried 50-100 mm
- ❖ Funnel traps placed next to border
- ❖ Trap (26 x 28 x 62 cm)
- ❖ 129 rats can be captured/trap
- ❖ In 33-116 days, 56320 rats were captured

Sanitary Design Aspects



Sanitary Design Aspects





Hermetic Structures for Raw Grain and Finished Feed

Cocoons™

Having the shape of a cube, impermeable to gases (hermetic), manufactured of white PVC, flexible, UV resistant. Designed for in or outdoor storage, for agricultural and non-agricultural commodities, dry and in bags. Can be installed at any location in minutes. Annual post harvest loss less than 0.25%. Effective life span 10-15 years.

150MT Cocoons Cargill, Philippines



150 MT Cocoons Rwanda





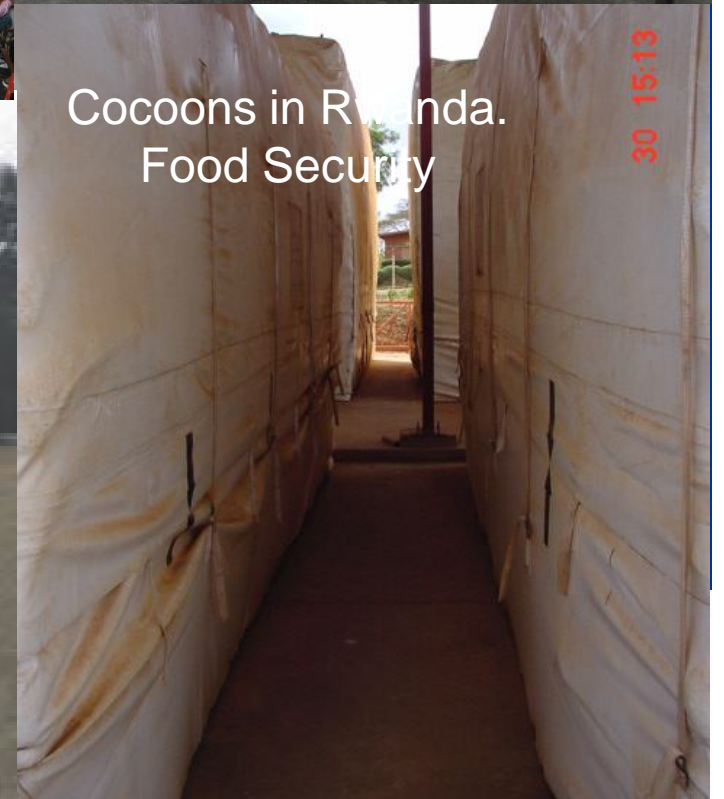
Cocoon in Laos. Grainbank.



Cocoons Bayer Philippines. Hybrid Rice.



Cocoons in Miramar, Costa Rica. Organic Coffee.



Cocoons in Rwanda.
Food Security

G-HF and V-HF Cocoons™

G-HF Cocoons™

Hermetic Fumigation with CO₂

Available in 5MT till 50MT, with identical configuration as standard Cocoons. In addition there is a gas inlet near the bottom and a gas outlet of 6" Ø at the top. Provided with all additional equipment for CO₂ injection. This method is being used for "fumigation" of a commodity and rapid elimination of all stages of insect development

V-HF Cocoons™

Vacuum-Hermetic Fumigation

For rapid fumigation of commodities of high value or for storage of commodities at low O₂ levels.

This technology eliminates all stages of insect development in three days at room temperature. El Cocoon The V-HF Cocoon is connected to a vacuum pump to reduce the O₂ in the Cocoon to a level lethal to the insects.



Prevent Access to Shelter

- ❖ Eliminate places to hide or breed
- ❖ Eliminate places to roost (birds)



Eliminate unsanitary conditions outdoors

Building Exterior



Shrubs should not be too close to building

Have an 18 ft vegetation-free barrier zone





Eliminate clutter:
Potential harborage sites for rodents/insects

Improper stocking or storage practices

Give 12 inches of space between the wall and pallets
Pallets, 6 inches off the floor



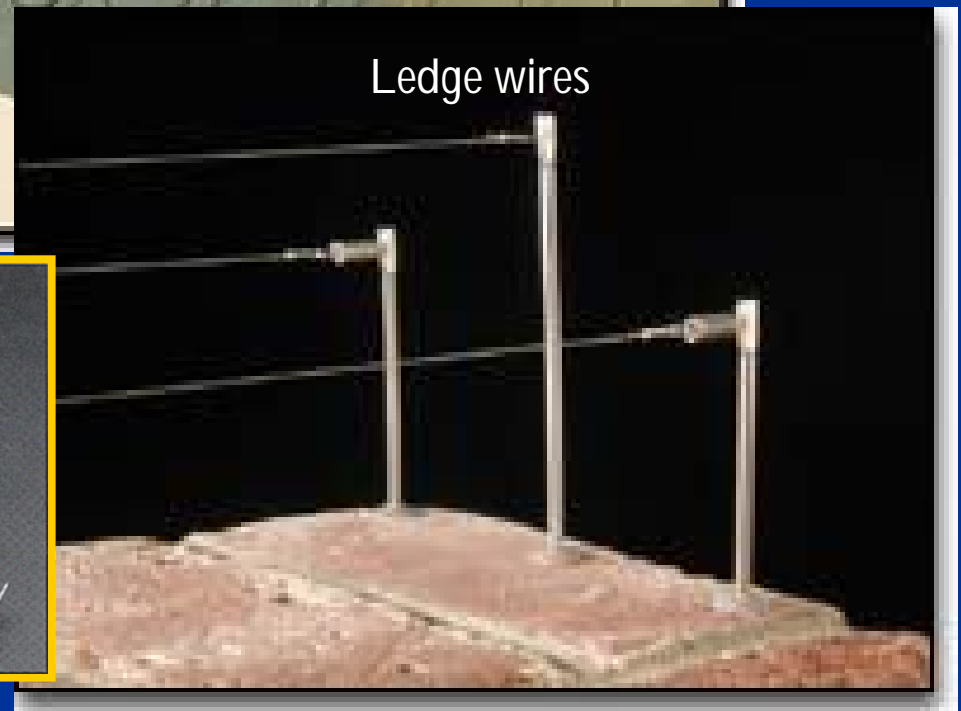
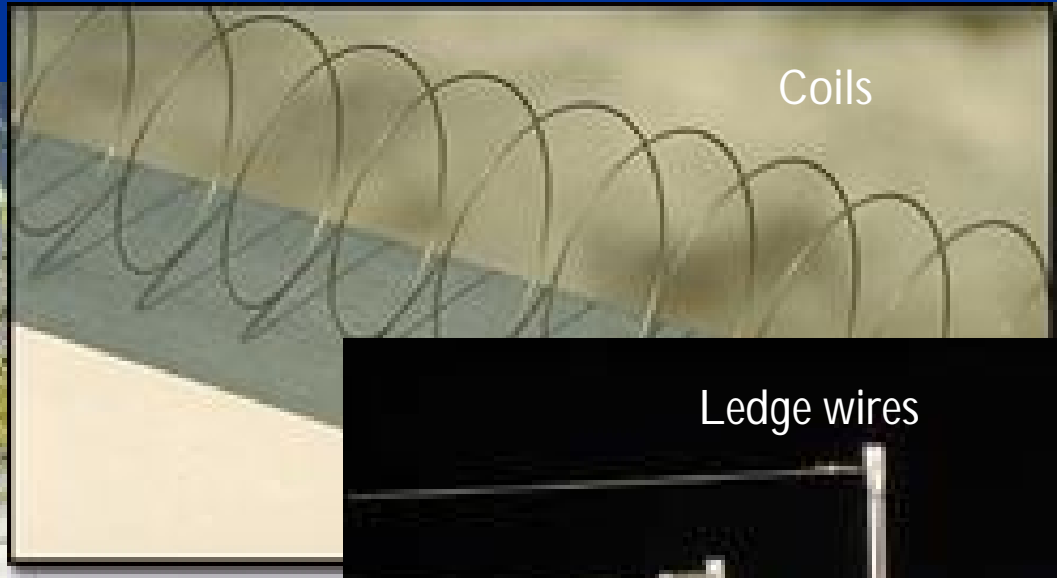
PRUNE TREES TO REDUCE ROOSTING



Netting to Exclude Birds



Tactile Deterrents for Birds





Sloped ledges exclude birds

Prevent Access to Moisture

- ❖ Eliminate standing water through good design and repair of grounds outside and inside the mill



Other Important Tactics

- ❖ Crack/crevice treatments for insects
- ❖ Fogging for insects
- ❖ Heat treatment for insects
- ❖ Use of fumigants for insects
- ❖ Physical barriers-air curtains, plastic strips near doors
- ❖ Use of baits (chemical and nonchemical)-insects, rodents, birds

Apply Pesticides Inside Mills

- ❖ Crack/crevice application
 - ❖ Cyfluthrin, fenvalerate, hydroprene
- ❖ General surface application
 - ❖ Diatomaceous earth
- ❖ Fogging
 - ❖ Resmethrin, Dichlorvos



Aerosols (fogging)



Kill exposed insects

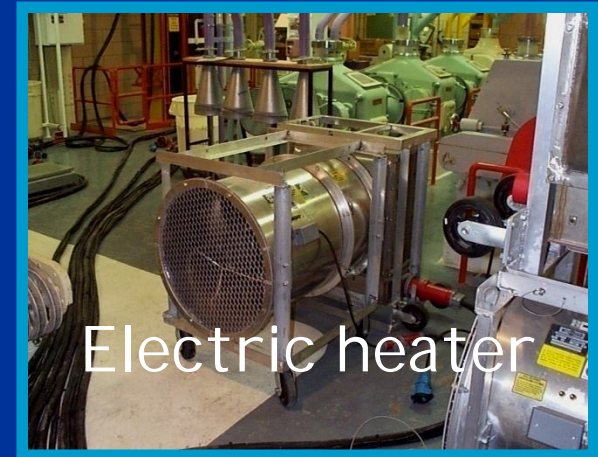
❖ **Heat treatment:** Raising the ambient air temperature to 122-140°F (50-60°C), and maintaining these temperatures for 24-36 hours



Gas heaters



Steam heater



Electric heater



Duct carrying heat from gas heaters

Once a Year



Fan

Use of Fumigants-Gases

- ❖ Phosphine for grain
- ❖ ECO₂Fume (2% phosphine and 98% carbon dioxide)-Grain and structures
- ❖ Methyl bromide-Structures
- ❖ ProFume (sulfuryl fluoride)-Grain and structures
- ❖ Should be applied by trained personnel
- ❖ Sealing of structures is important
- ❖ Fumigation does not prevent re-infestation
- ❖ Fumigation has no effect on damage done!



Fumigation



Gas monitoring and personal protective equipment are essential

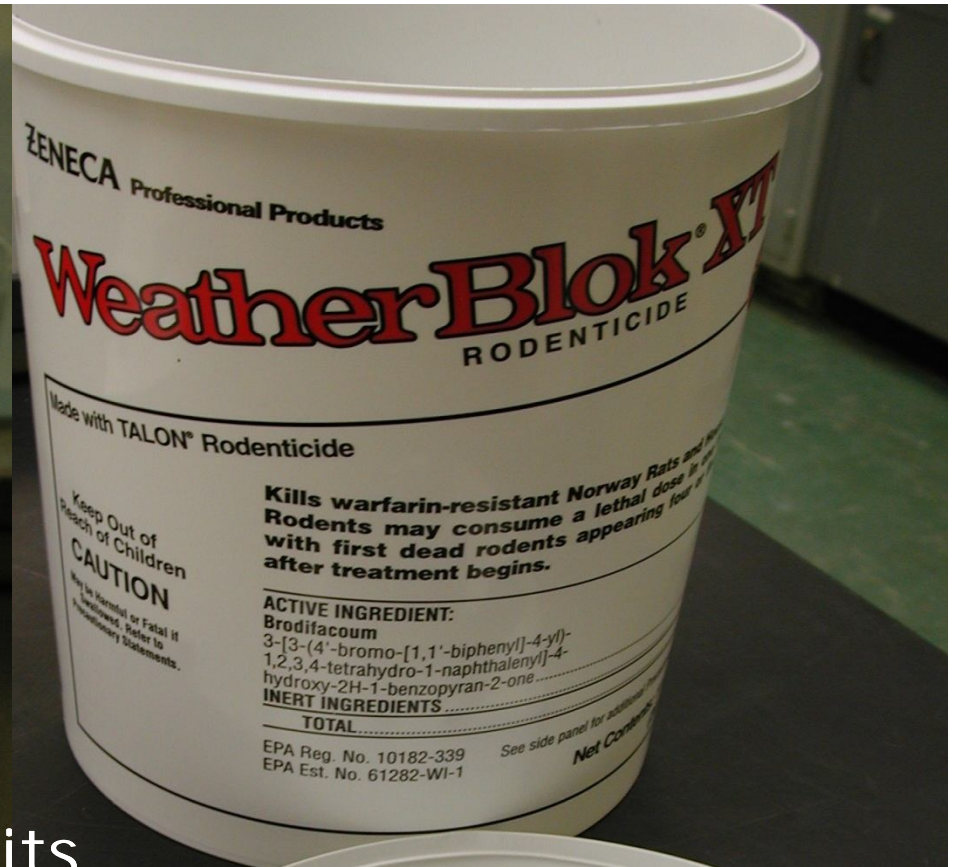
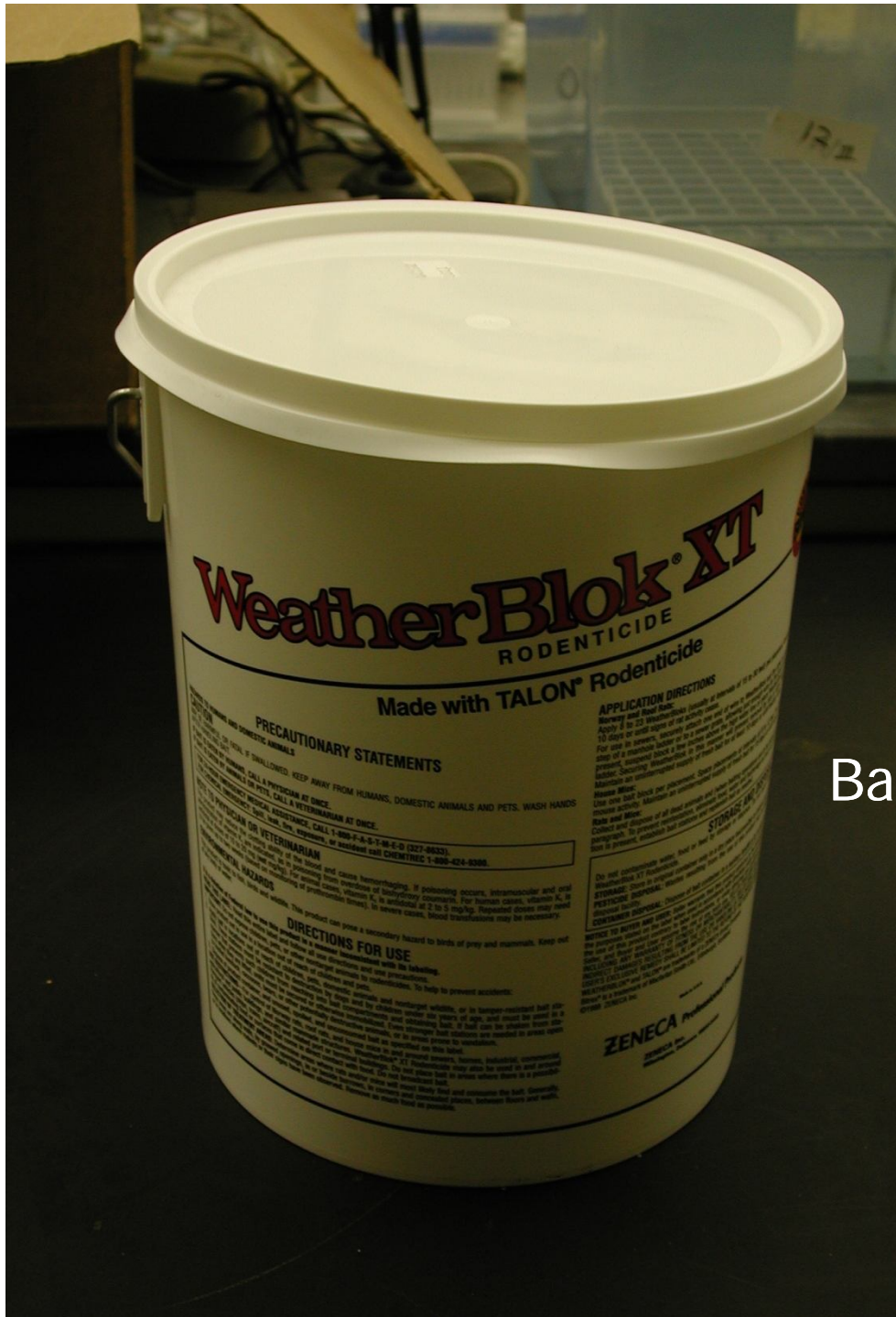
Rodenticides and Baits

❖ Anticoagulants

- ❖ **Multiple-dose:** Diphacinone, Chlorophacinone, Warfarin
- ❖ Kill rodents in 3 – 18 days
- ❖ **Single-dose:** Brodifacoum, Bromadiolone, Difethialone
- ❖ 1-2 grams will kill rodents after a single feeding

❖ Non-anticoagulants

- ❖ **Bromethalin**
- ❖ 2.5 – 8 grams to kill rodents
- ❖ Death in 12 h – 4 days
- ❖ **Zinc Phosphide:** succumb in 17 minutes, death in 12 - 24 hours
- ❖ **Cholecalciferol (Vitamin D₃)**

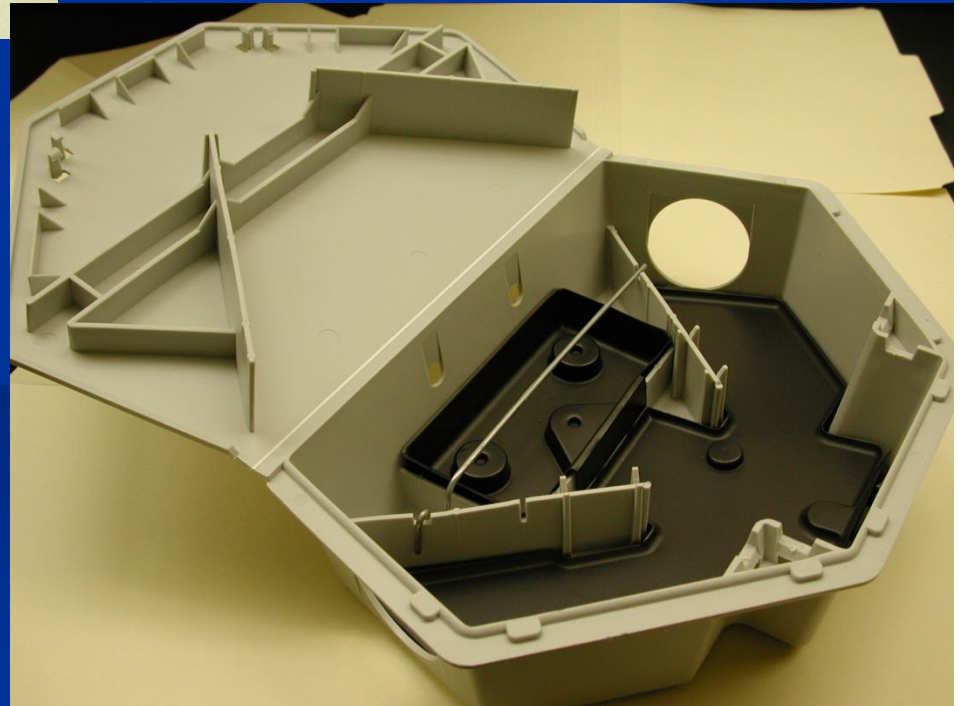


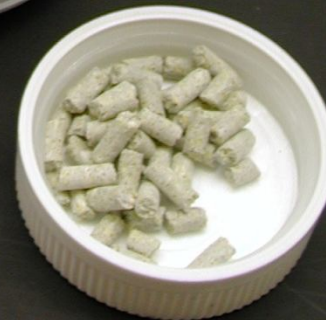
Baits





Bait Boxes





Baits-Pellets

Good Housekeeping

d-CON

READY MIXED BAITBITS

KILLS MICE AND RATS

4 READY-TO-USE BAIT FILLED TRAYS

CAN KILL IN ONE FEEDING

Mice and rats will die within 4 or 5 days

Keep out of reach of children.
 May be harmful or fatal if swallowed.
 Read additional precautionary statements on back panel.


CAUTION:

ACTIVE INGREDIENT: Brodifacoum 3-[3-(4-bromo-[1,1'-biphenyl]-4-yl)-1,2,3,4-tetrahydro-1-naphthalenyl]-4-hydroxy-2H-1-benzopyran-2-one.....	0.005%
INERT INGREDIENTS.....	99.995%
	TOTAL 100.000%

NET CONTENTS 4/3.0 OZ. (85g) NET WT. 12 OZ. (340g)

d-CON READY MIXED BAITBITS

KILLS WARFARIN-RESISTANT HOUSE MICE AND WARFARIN-RESISTANT NORWAY RATS



FLAVOR ATTRACTIVE TO MICE AND RATS

d-CON READY MIXED BAITBITS

KILLS MICE AND RATS

READY-TO-USE BAIT TRAY

KILLS WARFARIN-RESISTANT HOUSE MICE AND WARFARIN-RESISTANT NORWAY RATS

CAN KILL IN ONE FEEDING

Mice and rats will die within four or five days.

KEEP OUT OF REACH OF CHILDREN
 May be harmful or fatal if swallowed.
 Read additional precautionary statements on back panel.

CAUTION:

ACTIVE INGREDIENT: Brodifacoum 3-[3-(4-bromo-[1,1'-biphenyl]-4-yl)-1,2,3,4-tetrahydro-1-naphthalenyl]-4-hydroxy-2H-1-benzopyran-2-one.....	0.005%
INERT INGREDIENTS.....	99.995%
	TOTAL 100.000%

NET WT. 3 OZ. Bait Tray (85g)

d-CON READY MIXED BAITBITS

TO RESEAL AND RELOAD BAIT TRAY

Liquid Baits

CUT HERE

Liqua-Tox II®

Mix contents of pouch with 1 quart of water.

Kills Rats & Mice

ACTIVE INGREDIENT:	
Sodium Salt of Diphacinone; (2-Diphenylacetyl-1, 3-indandione).	0.106%
INERT INGREDIENTS	99.894%
TOTAL	100.000%

KEEP OUT OF REACH OF CHILDREN
CAUTION
(See back panel for additional precautionary statements.)

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS & DOMESTIC ANIMALS

CAUTION: Keep away from humans, domestic animals and pets. If swallowed, this material may reduce the clotting ability of the blood and cause bleeding. Exposure during pregnancy should be avoided. Avoid contact with skin, eyes, or clothing.

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED: Call a physician or Poison Control Center immediately. Drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person.

IF IN EYES: Flush eyes with plenty of water. Call a physician if irritation persists.

IF ON SKIN: Wash with plenty of soap and water.

NOTE TO PHYSICIAN: If ingested, administer Vitamin K, intramuscularly or orally as indicated in bishydroxycoumarin overdoses. Repeat as necessary based on monitoring of prothrombin times.

ENVIRONMENTAL HAZARDS

Keep out of lakes, streams, or ponds. Do not contaminate water by cleaning of equipment or disposal of wastes.

NET CONTENTS: 1.68 Fl. Oz. (49.68 ml)

Mfg. by:  **Bell Laboratories, Inc.**
Madison, WI 53704 U.S.A.

EPA Est. No. 12455-WI-1
EPA Reg. No. 12455-61

APPLICATION DIRECTIONS:
RATS: Provide a minimum of 1 pint (16 fluid ounces) of LIQUA-TOX II in each dispenser (suitably-equipped bait station, chick fountain, or other suitable device). If infested area is large, or if rat population appears to be high, use additional dispensers at intervals throughout the infested area.

these areas are along walls, by gnawed openings, beside burrows, in corners and concealed places, between floors and walls, or in locations where rodents or their signs have been seen.

Integrated Pest Management of Cockroaches

INSPECTION AND MONITORING - Pheromone traps, sticky traps, and contour mapping

SANITATION - Removal of food, water, and harborage

PHYSICAL REMOVAL/CONTROL - Trapping and vacuuming, heat

USE OF CAULKING - Elimination of harborage sites

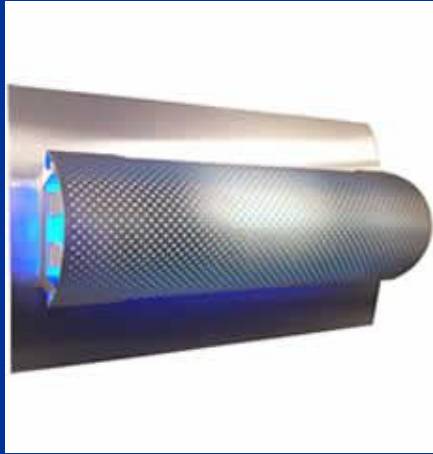
USE OF INSECT GROWTH REGULATORS - Hydroprene

USE OF BAIT S - Avermectin, boric acid, hydramethylnon

DIRECTED INSECTICIDE APPLICATIONS - crack and crevice

Fly Management

Movie



Light traps



Baits



Summary

- ❖ Feed manufacturer should...
 - ❖ Have a commitment to address sanitation and pest management problems
 - ❖ Collect data on type of pests encountered
 - ❖ Monitor pests and maintain data on pest incidence, abundance, and management
 - ❖ Develop scope of services for pest management
 - ❖ Develop SOPs for outside pest management contractors
 - ❖ Evaluate benefits of pest management programs and revise when needed

Thank You

