Pest Management in Feed Mills

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Research and Extension

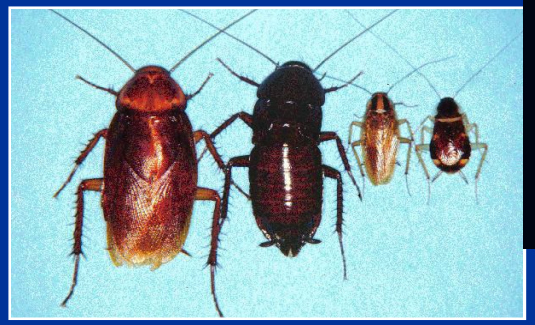
Pests

Invertebrate pests:

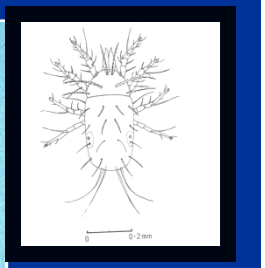
Stored-product insects

Filth flies

Cockroaches

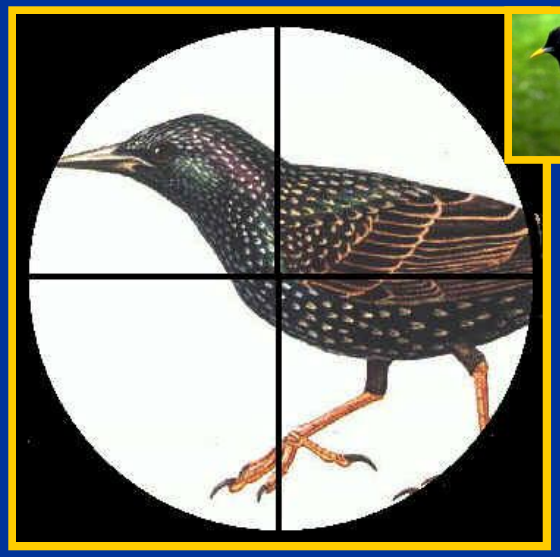


Mites



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

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

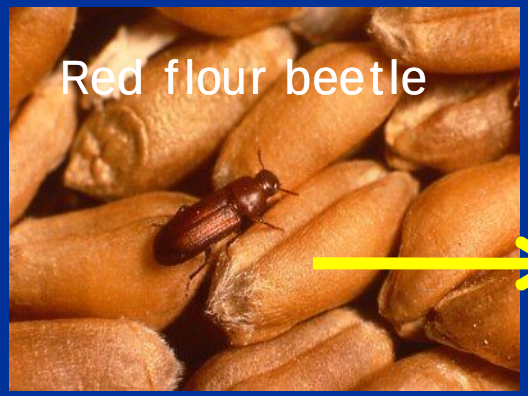
Processing plant

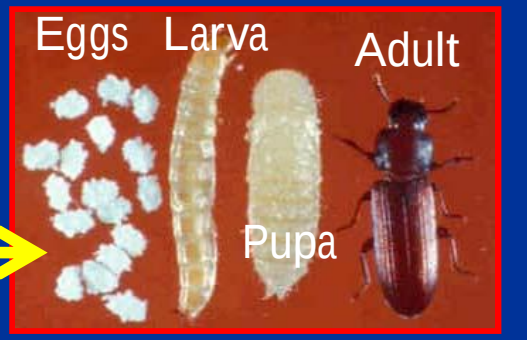
Retail store

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 30ºC

Reproductive Potential of Stored-Product Insects

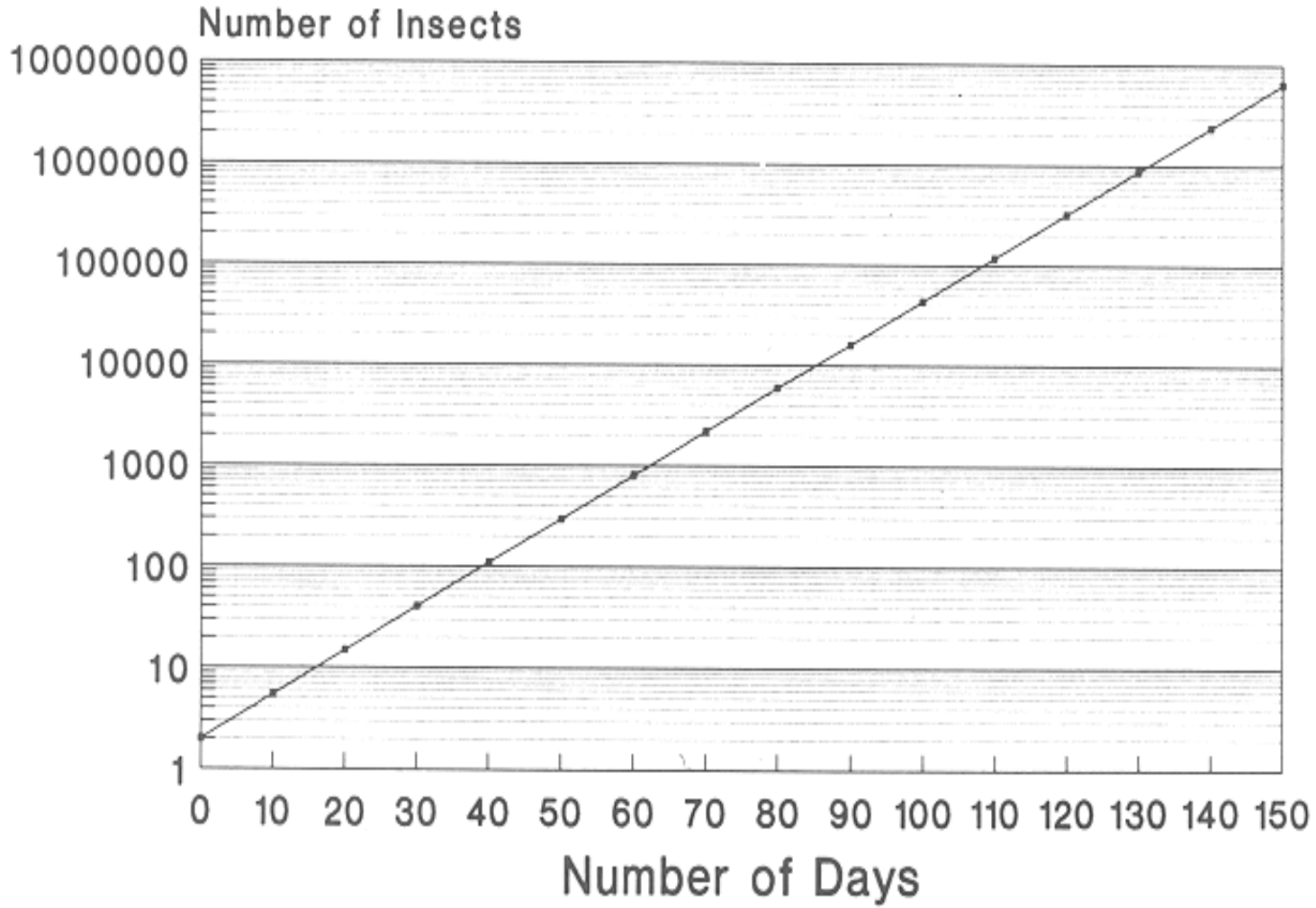


Fig. 3. The intrinsic rate of population increase for *Tribolium castaneum* at 28.5°C and 65% rh. (Data from Leslie and Park, 1949)

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

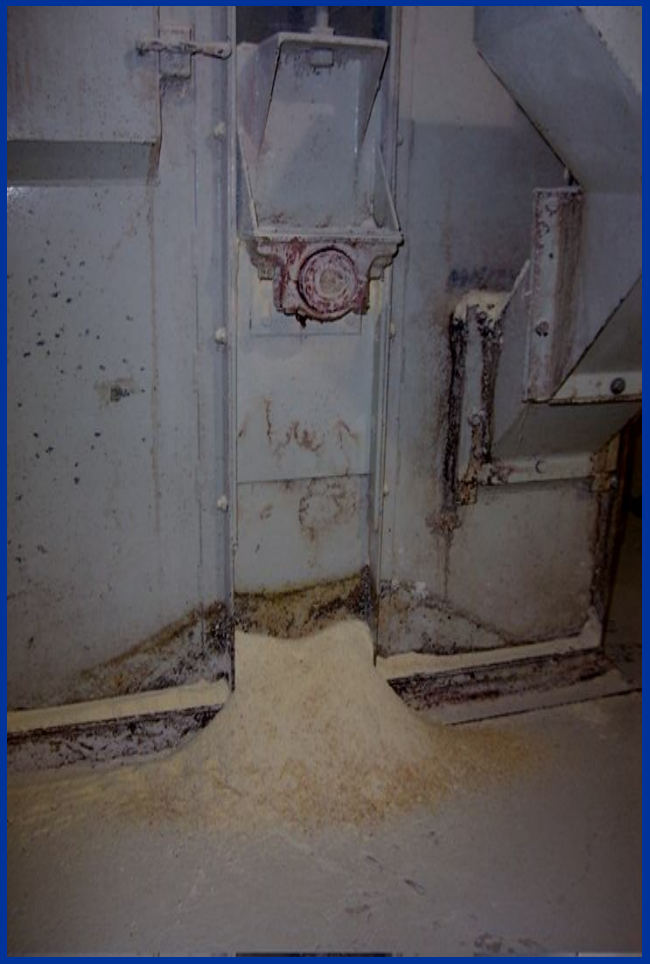
Means within a mill followed by different letters are significantly ($P < 0.05$) different

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

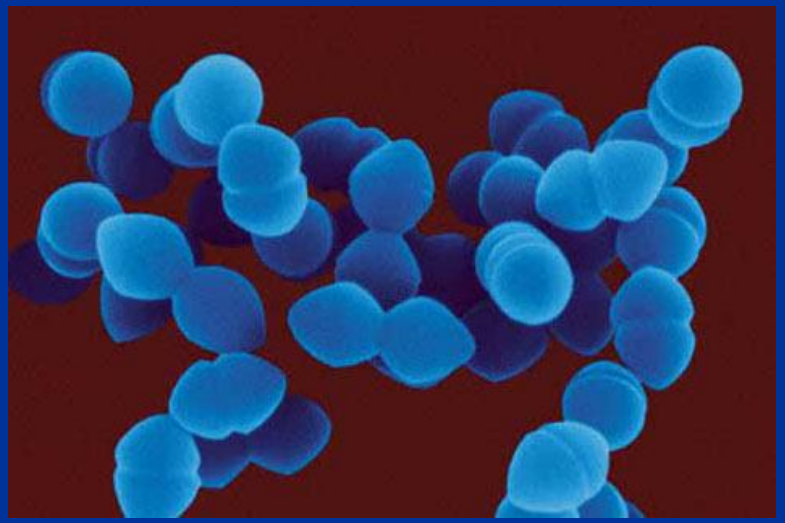


Association of Stored-Product Insects with Pathogens

- 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)

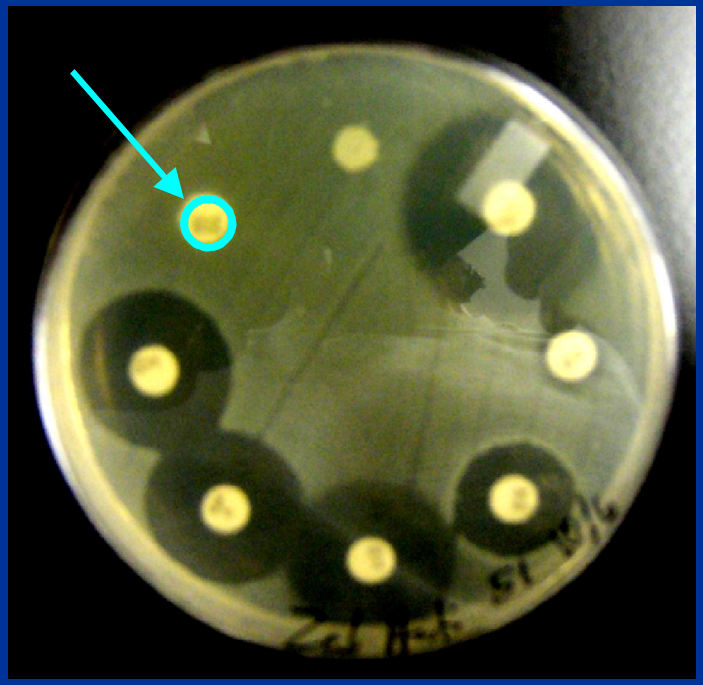
Antibiotic Resistance Screening of Enterococcal species in Stored-Product Insects and Feed Mill Product Samples

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

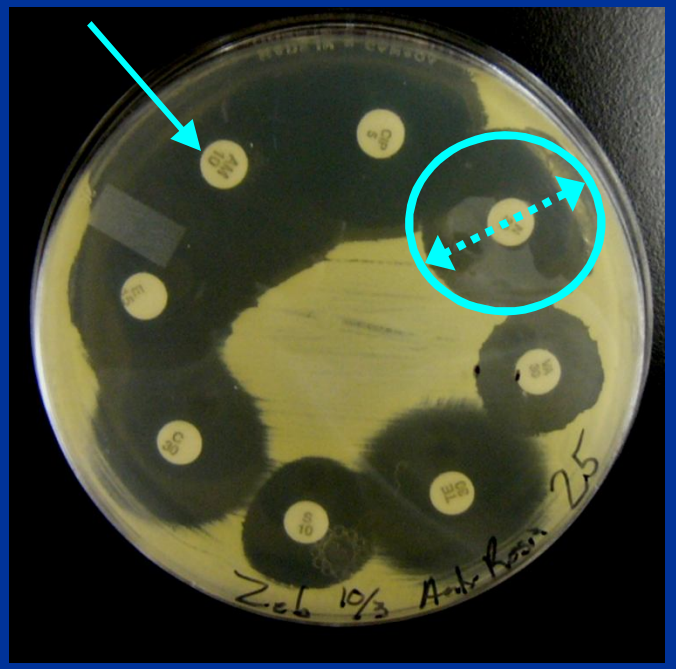


Lakshmikantha, HC and Bh Subramanyam (2009, Unpublished data)

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 (%)
Insects from feed mill			
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	$3.8 \pm 0.8 \times 10^{1}$

Prevalence of Enterococci in Feed Samples

Source	No. feed samples	Prevalence (%)	No. enterococcal isolates	Mean ± 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	$4.0 \pm 3.0 \times 10^3$

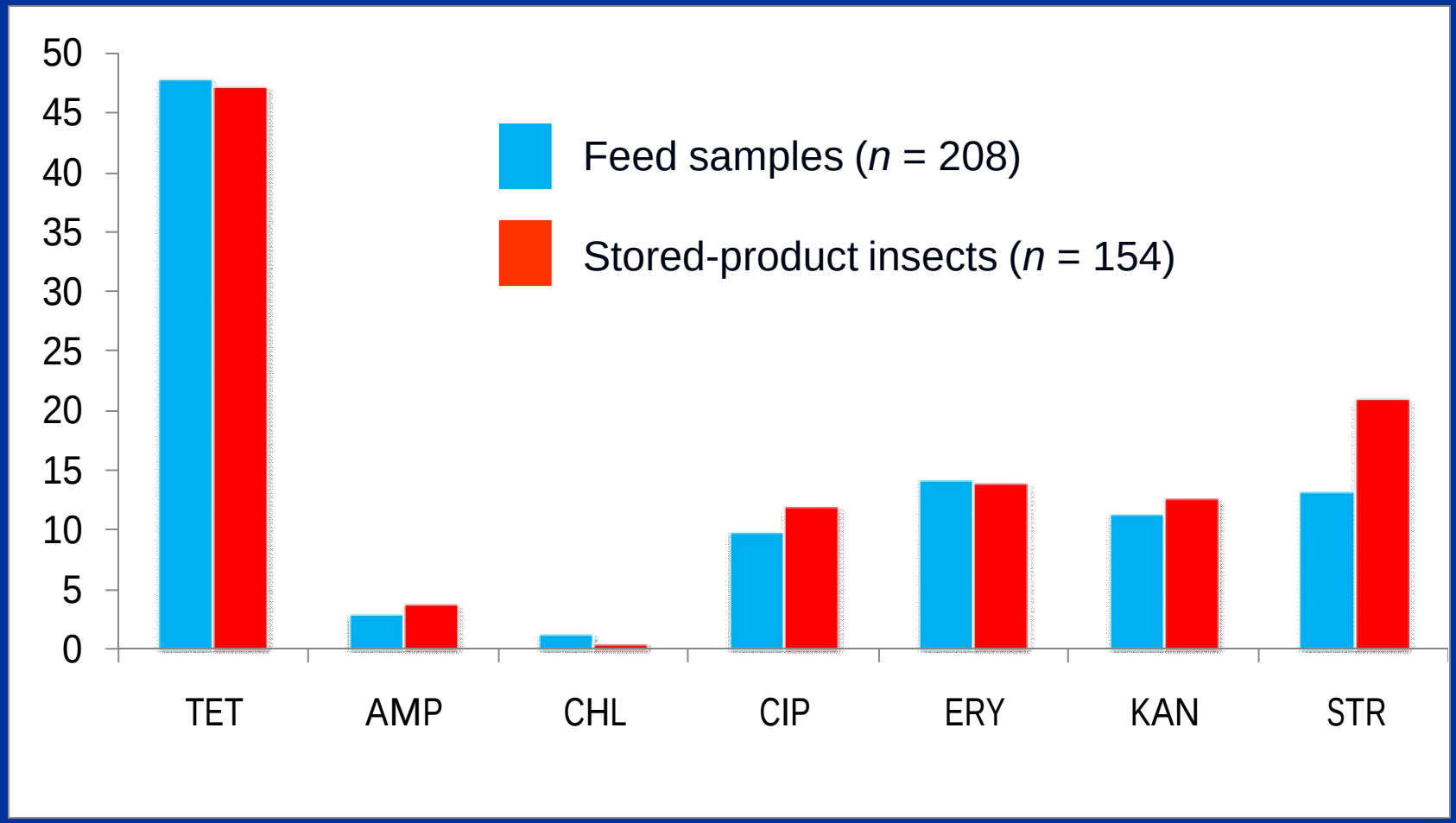
[a]Data based on 2 swine farms
[b]Data based on 6 feed mills

Enterococcal Species Distribution

Source	Total isolates	Number of isolates (%)				
		E. faecalis	***E. faecium***	***E. gallinarum***	***E. casseliflavus***	***E. hirae***
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 ± SEM / g	*T. castaneum* Mean ± SEM / insect		Transmission of *E. faecalis* to sterile poultry feed by *T. castaneum* Mean ± 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

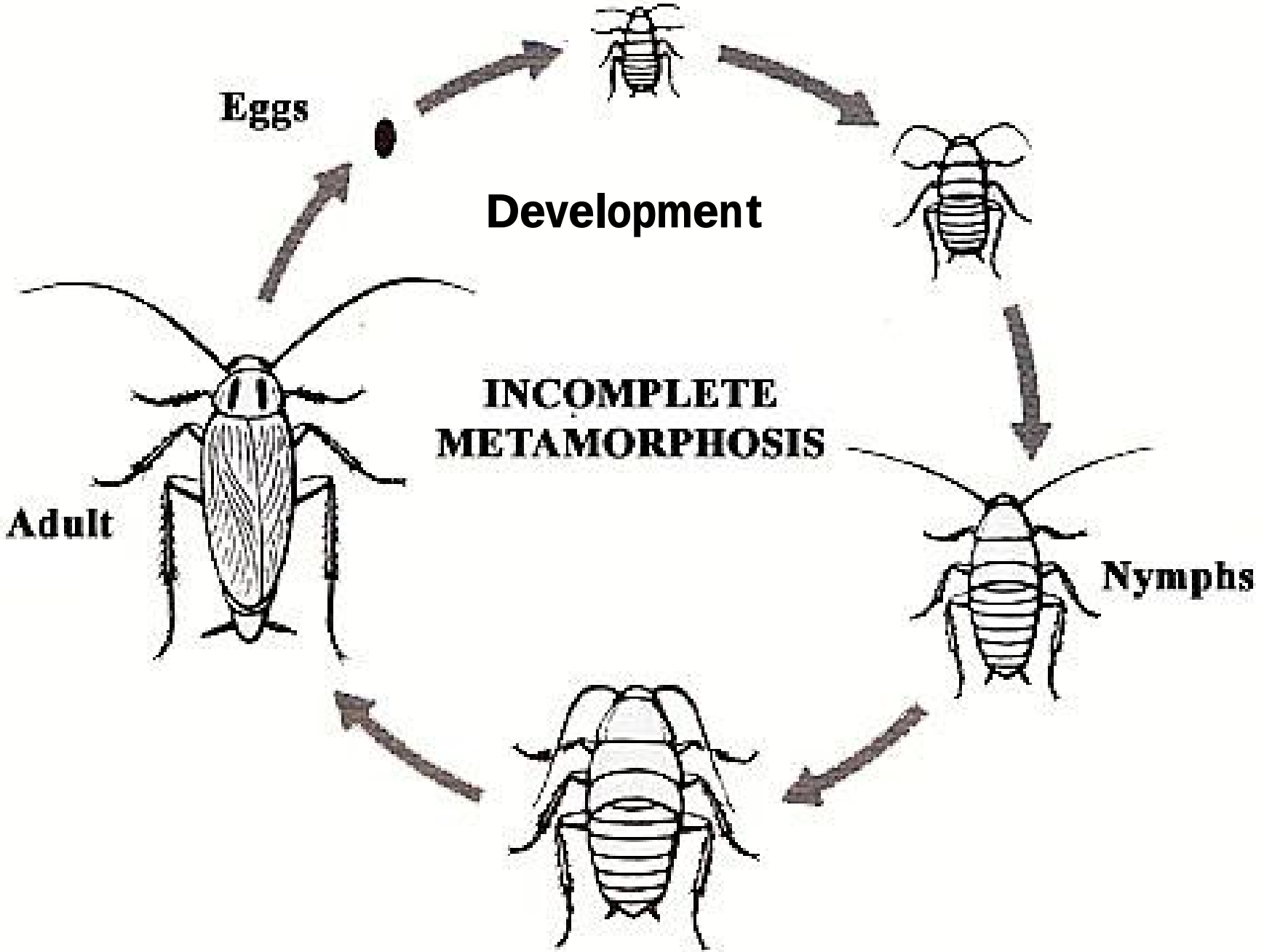
Initial *E. faecalis* concentration was $4.6 \pm 0.3 \times 10^6$

[a]Each mean is based on $n = 3$ replications

[b]Means within a column followed by different letters are significantly different ($P < 0.05$; by Fisher's Protected LSD test)

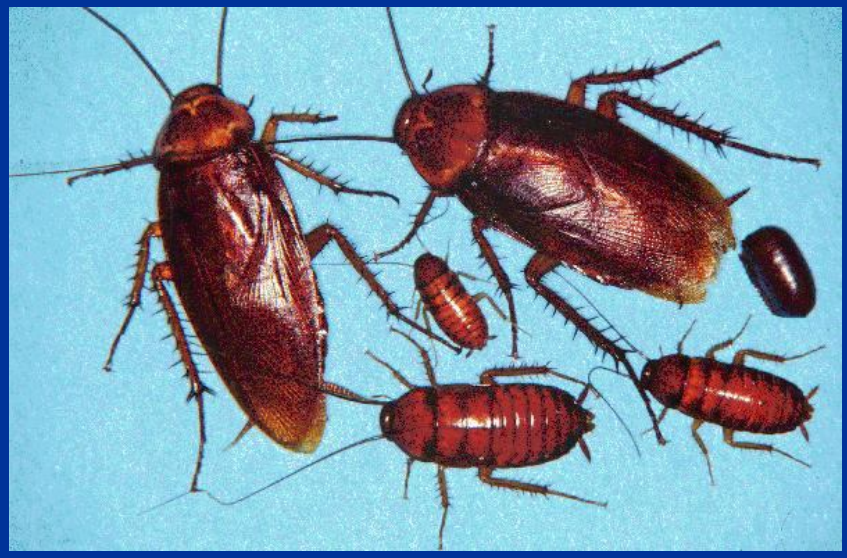
Cockroaches and Public Health

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


Eggs
Development
INCOMPLETE
METAMORPHOSIS
Adult
Nymphs

German Cockroach

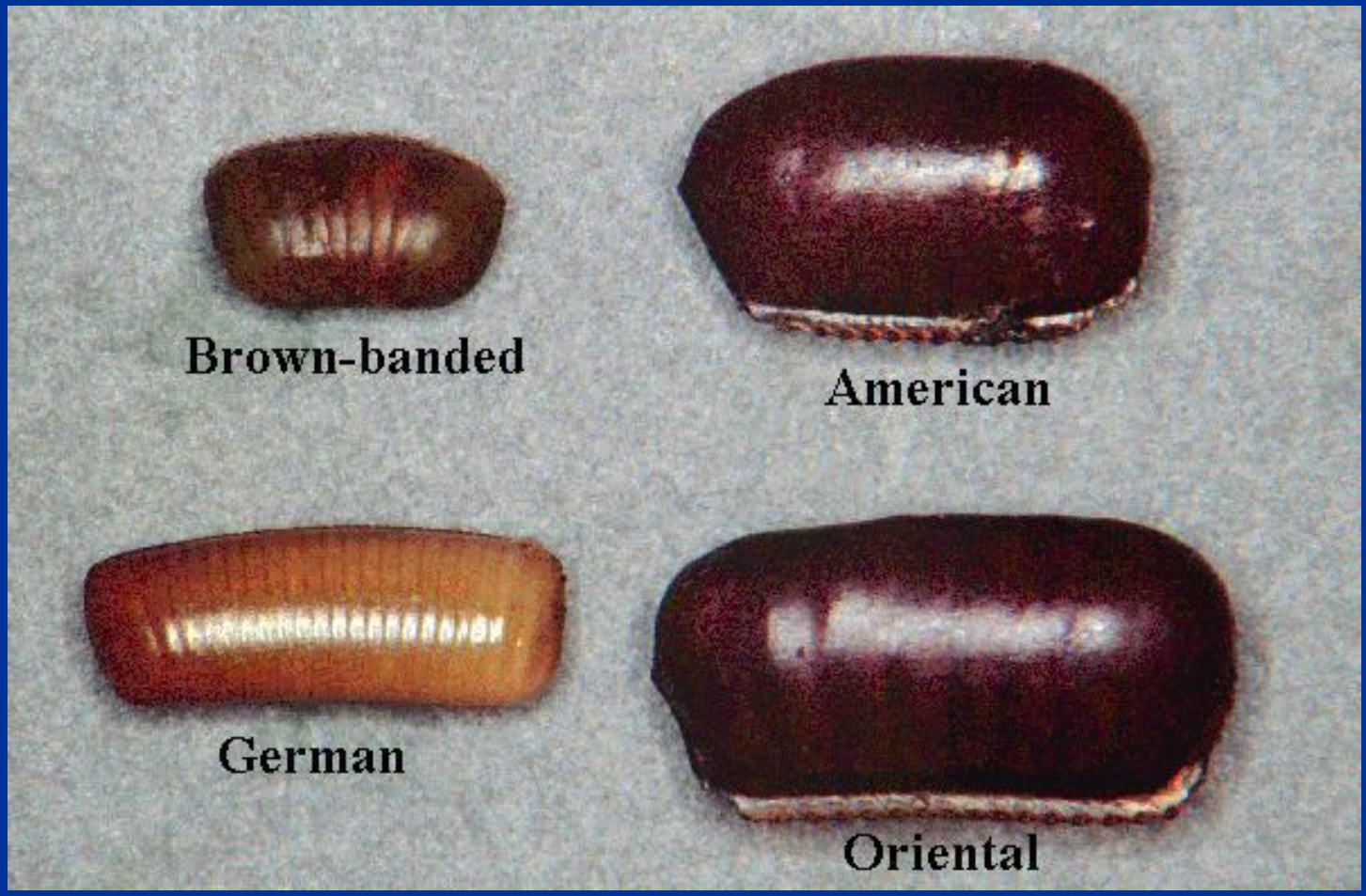
American Cockroach



Oriental Cockroaches

Brown-banded Cockroach

Egg Cases (Ootheca) of Cockroaches

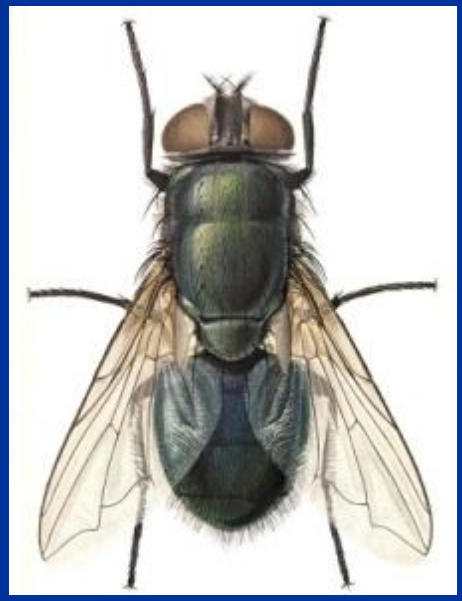


Biological Differences Among Cockroaches

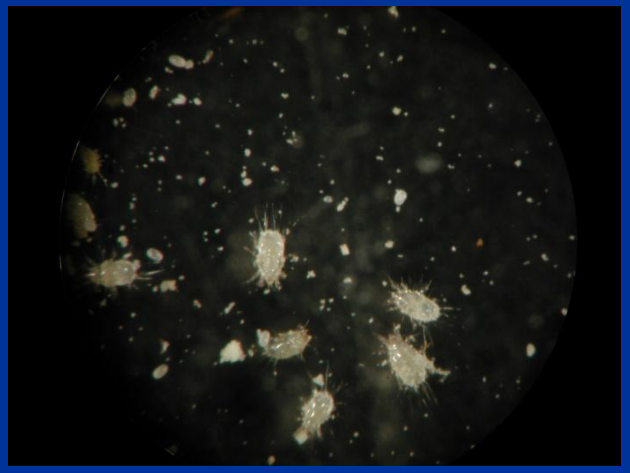
Species	Eggs/ Case	Egg cases/ lifetime	Egg stage (days)	Nymphal stage (days)	Adult longevity (months)
German	30 - 48	4 - 8	21- 28	40 - 125	< 12
American	14 - 18	12 - 24	30 - 60	160 - 971	14 - 15
Oriental	14	6 - 8	40 - 60	120 - 365	> 12
Brown-banded	13 - 18	14	50 - 75	95 - 276	< 10

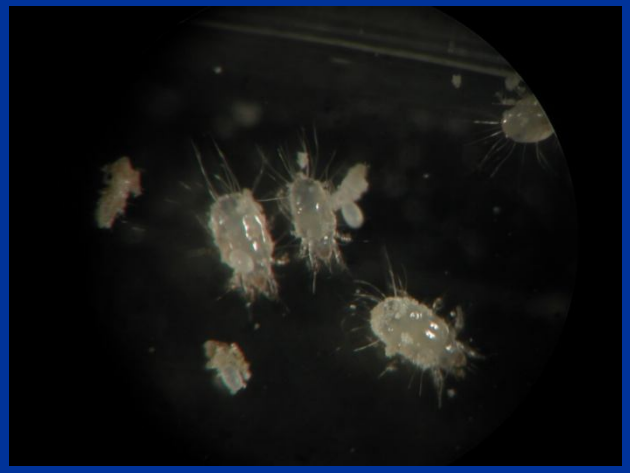
Flies

House Fly



Stored-Product Mites





- 8 legs (6 for insects)
- Develop at ≥9-35°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

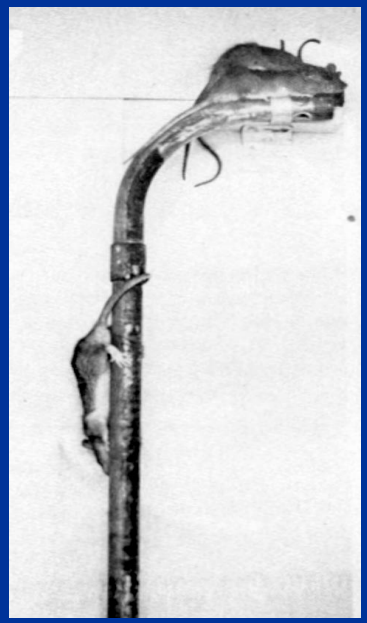
Rats and Mice

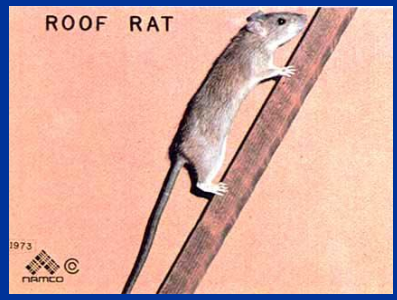
- Family Muridae has 500 species
- Rats and mice of SE Asia include:
  - Rice field rat, *Rattus argentiventer*
  - The black rat, *Rattus rattus diardii*
  - The wood rat, *Rattus tiomanicus*
  - The Norway rat, *Rattus norvegicus*
  - Little Malay rat, *Rattus exulans*
  - Greater bandicoot rat, *Bandicota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

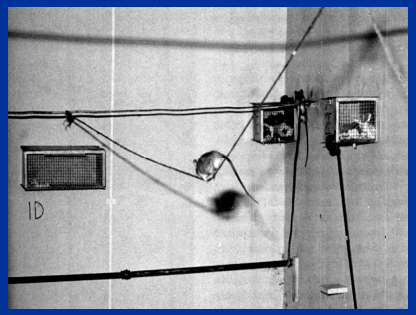
R. argentiventer (GR Singleton)

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

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

- 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
  - Heirarchy-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

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!

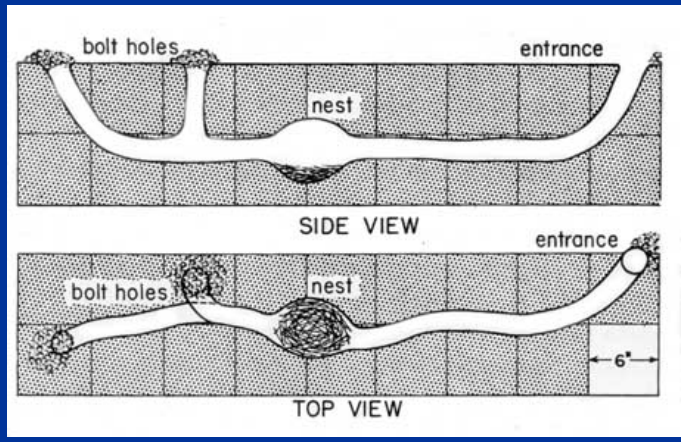
Continent	Production (Million tons)	Gained production (Million tons)	No. extra people nourished (Millions)	Percentage of Undernourished benefiting
Asia	1086.46	54.32	217.3	39
Latin America	156.70	7.74	31.3	60
Africa	113.66	5.68	22.7	11
Europe	37.70	1.89	7.5	26
Total (world)	1394.52	69.73	278.8	34

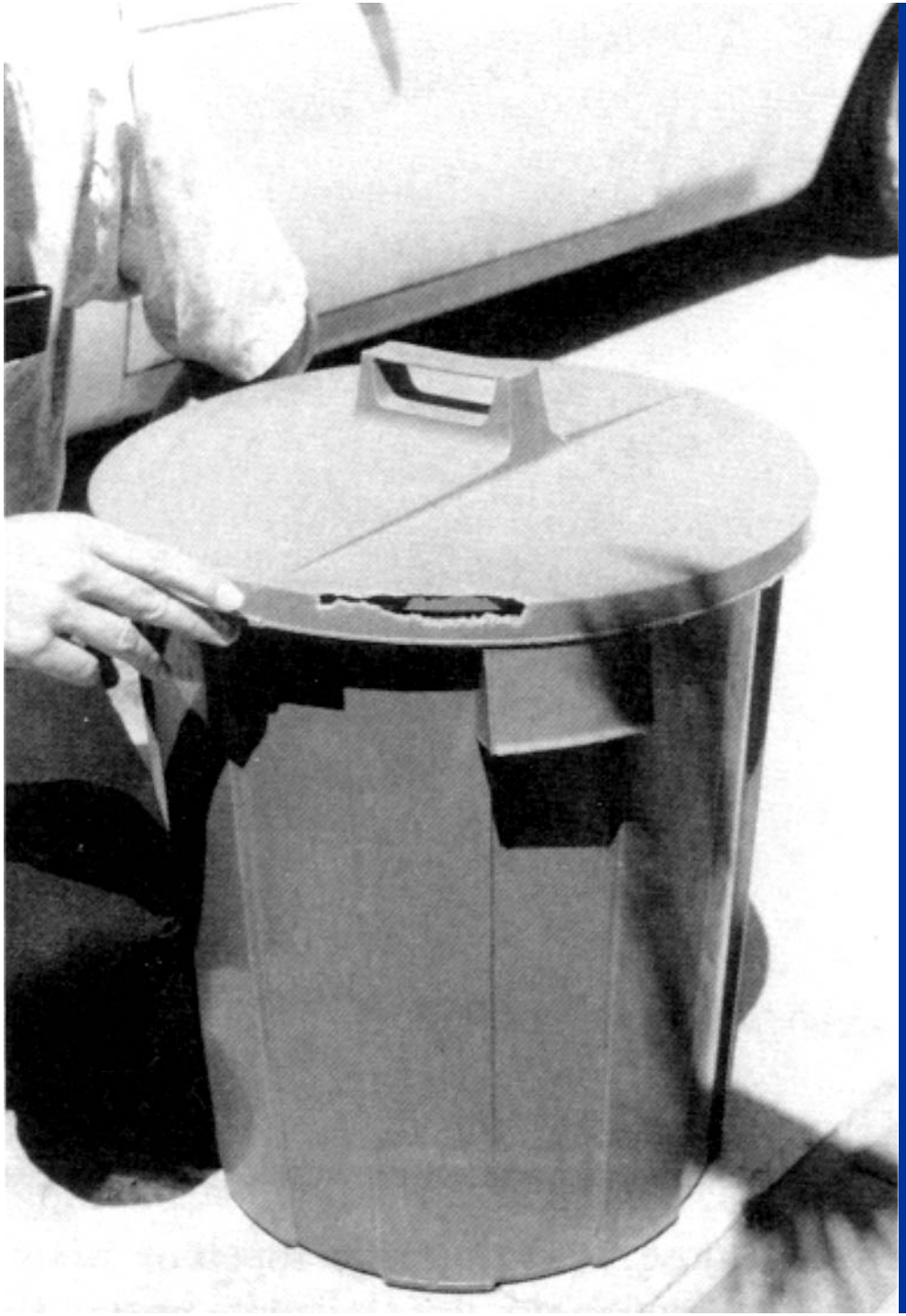
Includes all cereals in 113 countries where undernourishment exists.

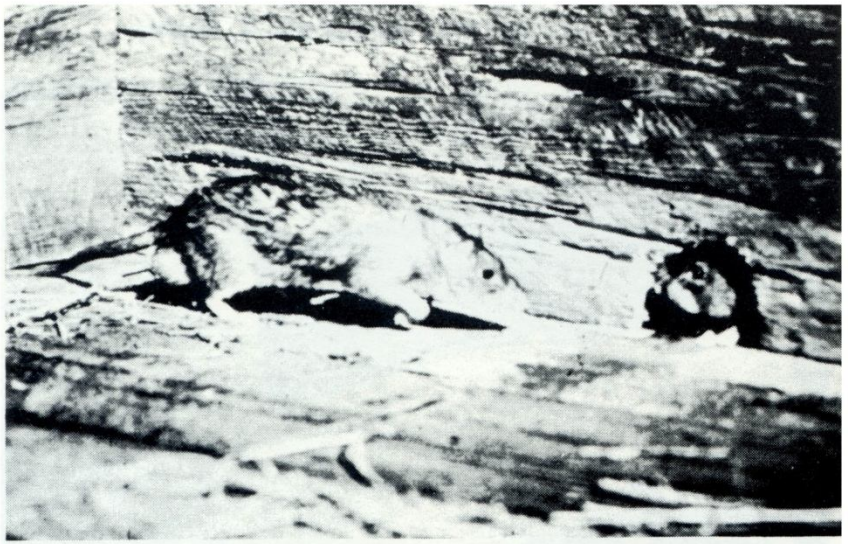
Source: Meerburg, BG, GR Singleton, and H Leirs. 2009. The year of the rat ends–time to fight hunger! Pest Manag. Sci. 65: 351-352.

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

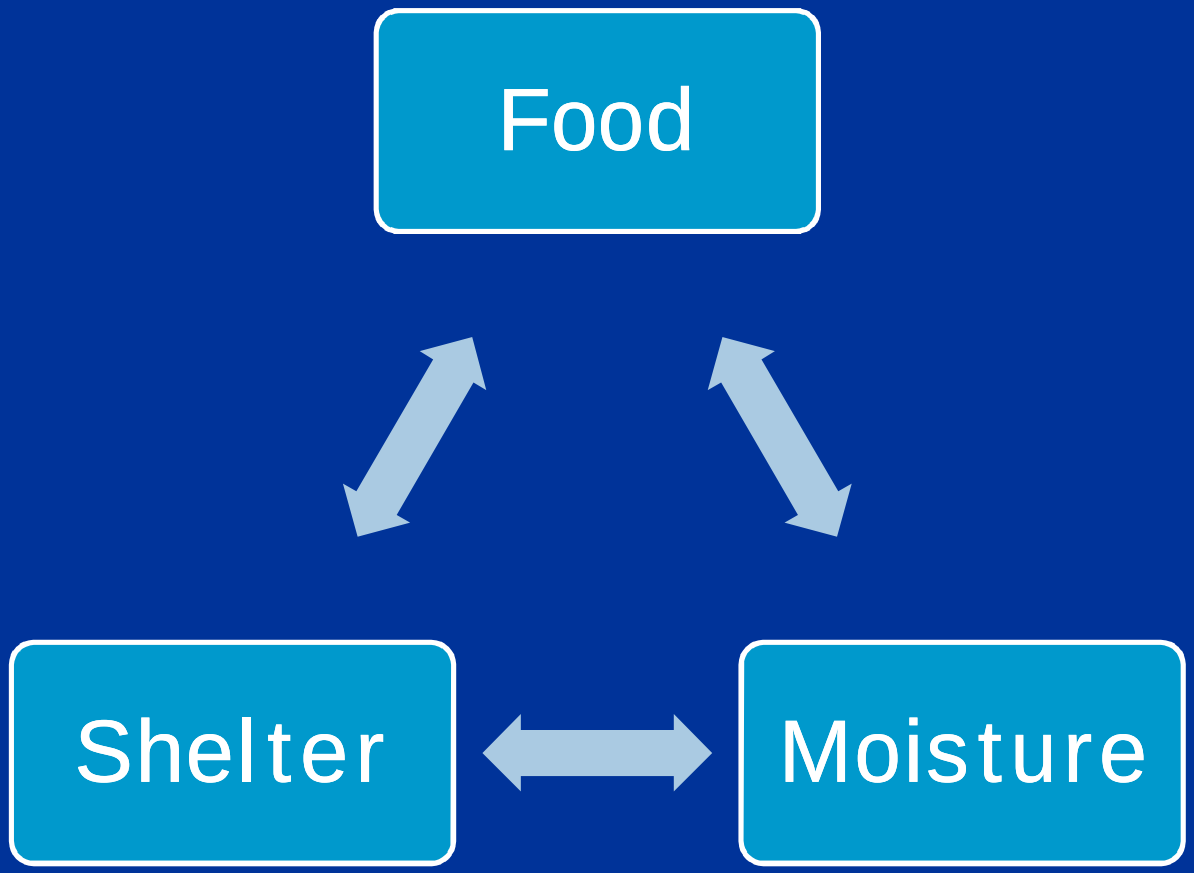
- Woodpeckers damage wooden structures
- Acidic feces are corrosive when moist
- Disintegrate tar-roofs, reduce roof's life expectancy
- Feces damage air conditioning equipment, siding, insulation, and machinery
- Feces create slippery conditions
- Bird nests can cause fires
- Blockage of ventilation 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
  - Asperigillosis, 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?



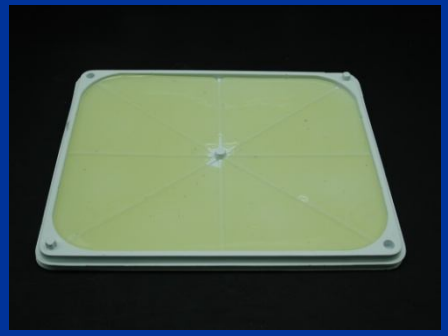
Integrated Pest Management (IPM)

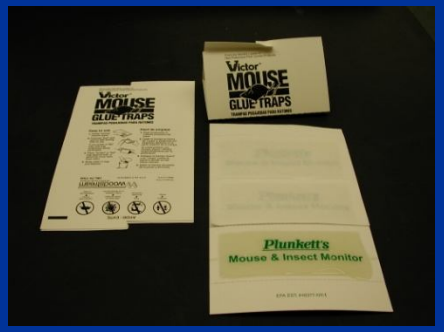
- Concepts:
  - Manage pests below unacceptable levels
  - Use multiple tactics
  - Use pesticides only as a last resort
  - Prevent access to food, shelter, and moisture

First Inspect, Monitor, Assess, and Evaluate

- Inspection
  - Visual (part of GMPs)
  - Inbound and outbound material, mill interior and exterior
  - Identifies source of pests, sanitation issues
- Monitoring
  - Traps and mechanical devices
- Assessing
  - Pest density and distribution
- Evaluation
  - Implement 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


Brandt

Rate Mill Infestation By Location for Sanitation

Probability of infestation or product loss

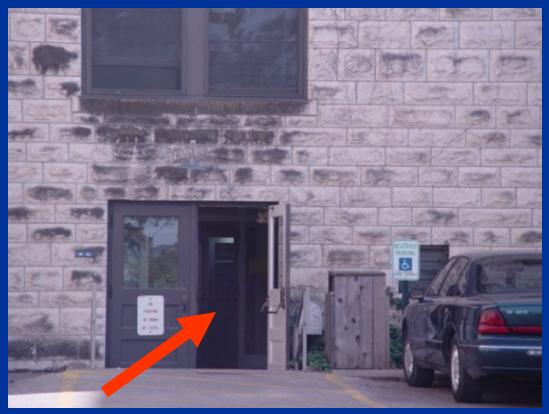
Cleaning frequency

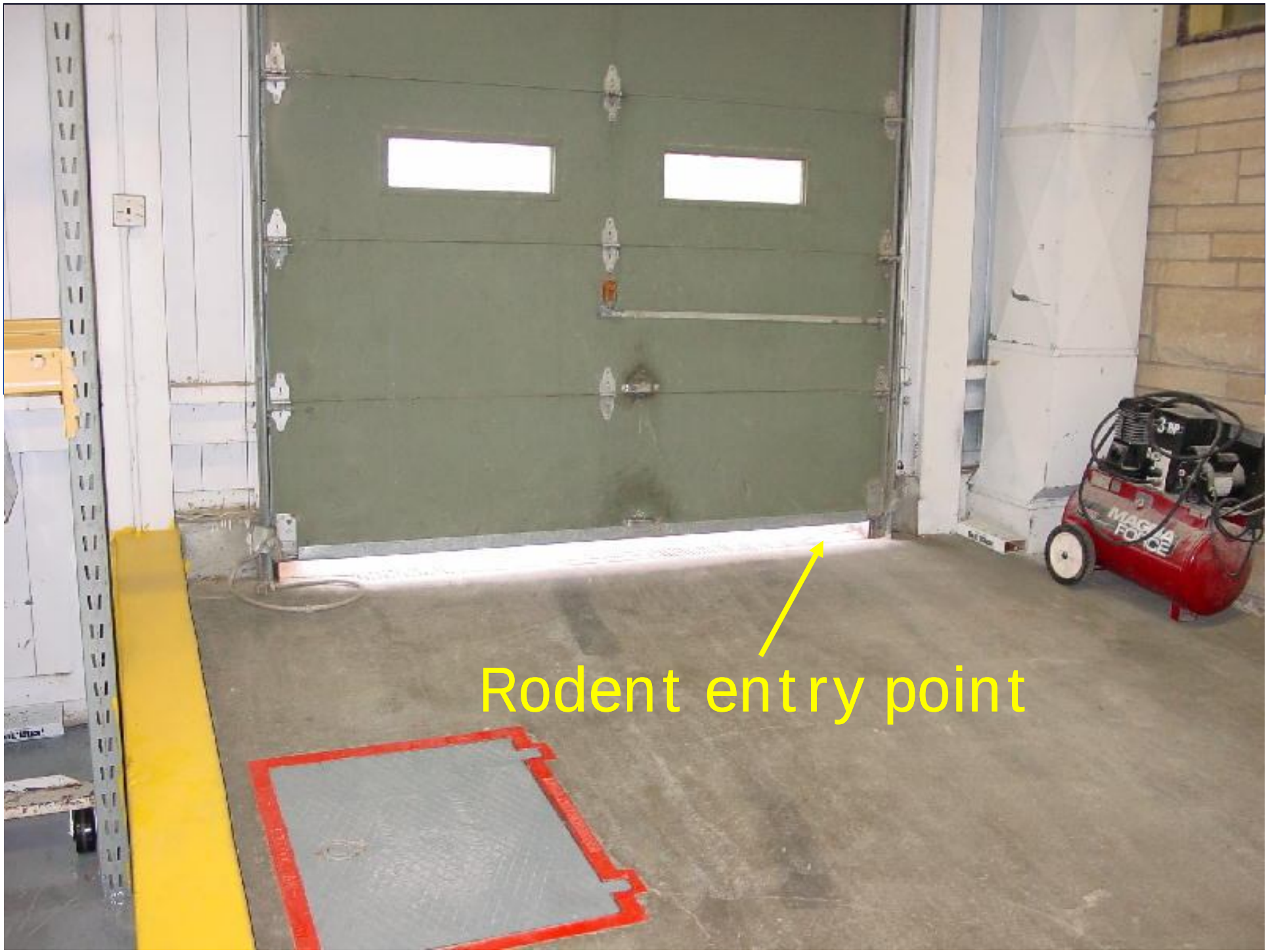
	High	Moderate	Low	Zero
Daily	Production Areas; receiving	Floors		
Weekly				
Monthly		Spouts; conditioner		Bathrooms
Yearly			Building exterior	

Remove Spillage

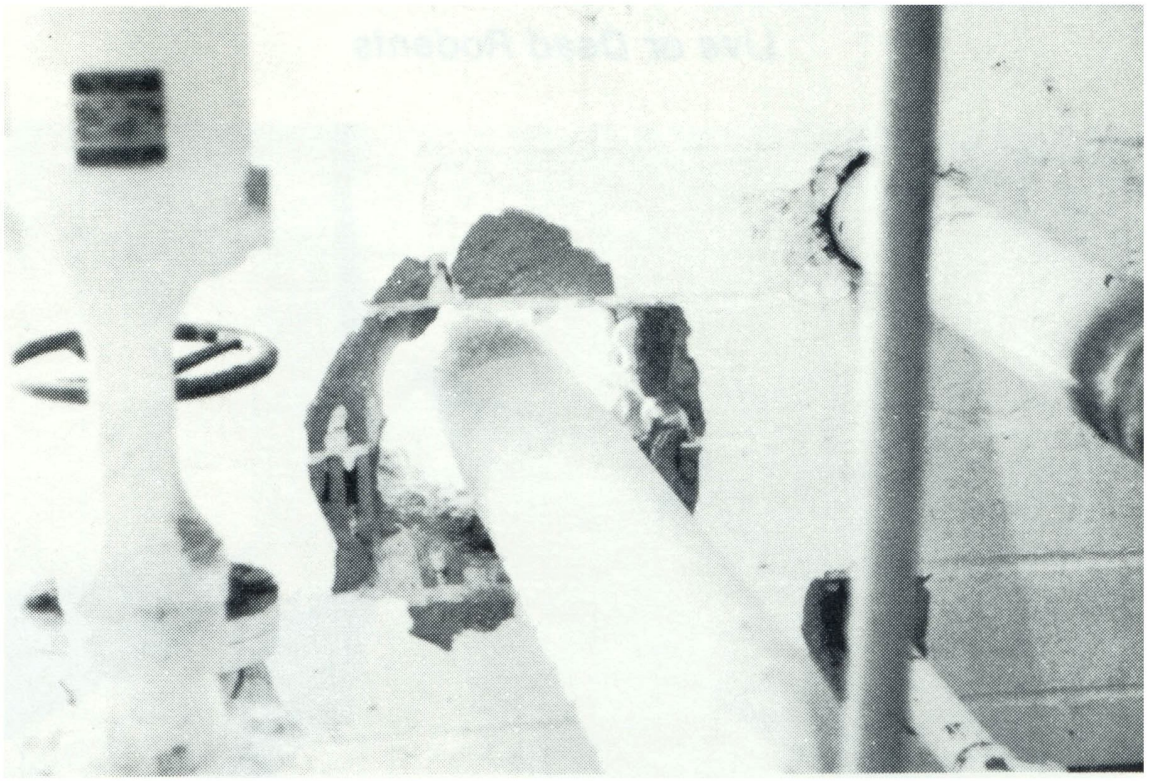

Avoid clutter:
Potential harborage sites for rodents/insects

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

GRAINPRO, INC.™
ORGANIC STORAGE SYSTEMS

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.

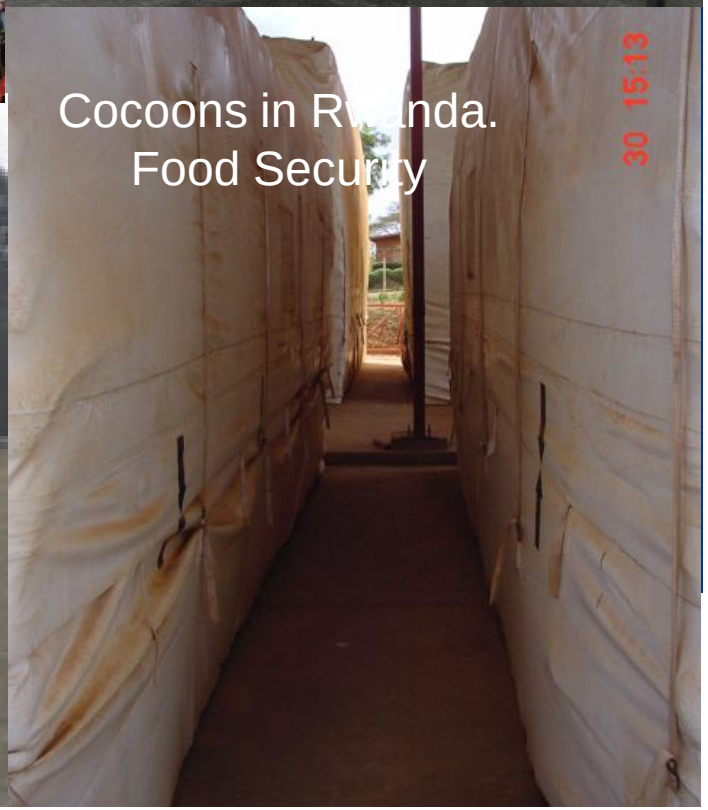
150MT Cocoons Cargill, Philippines

150 MT Cocoons Rwanda

Cocoon in Laos. Grainbank.

Cocoons Bayer Philippines. Hybrid Rice.

Cocoons in Miramar, Costa Rica. Organic Coffee.



Cocoons in R nda.
Food Secur y

G-HF and V-HF Cocoons™

G-HF Cocoons™

Hermetic Fumigation with CO_2

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 CO_2 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 O_2 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

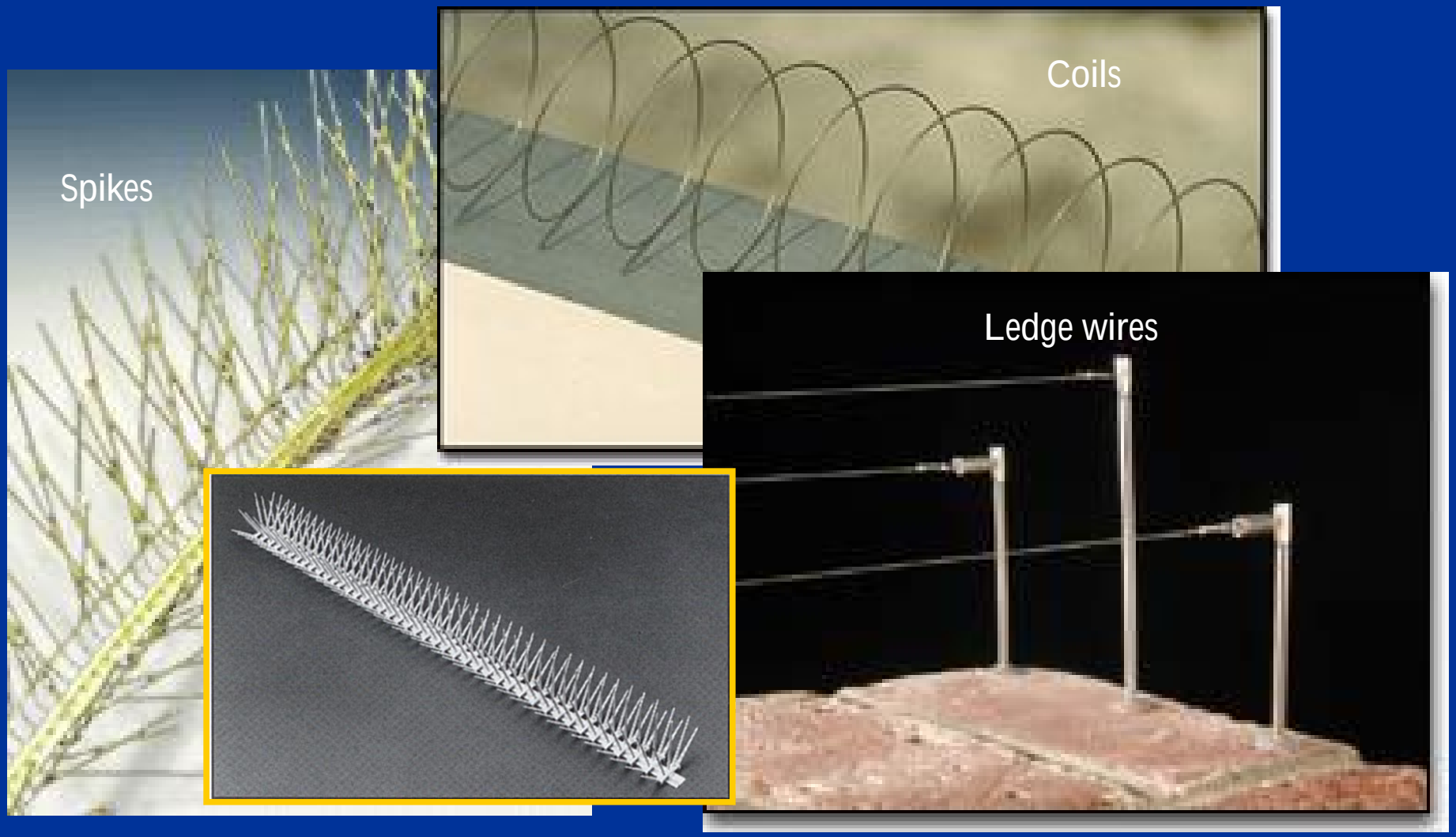
Improper stocking or storage practices

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 122-140ºF (50-60ºC), 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
- ECO_2Fume (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

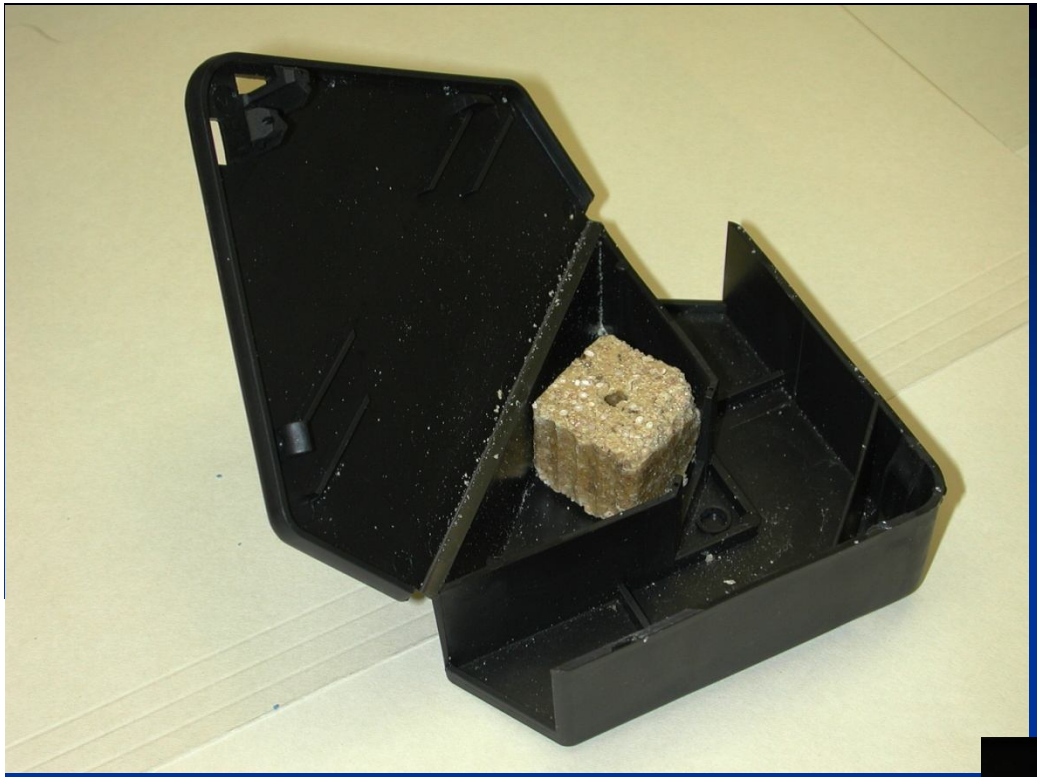
Gas monitoring and personal protective equipment are essential

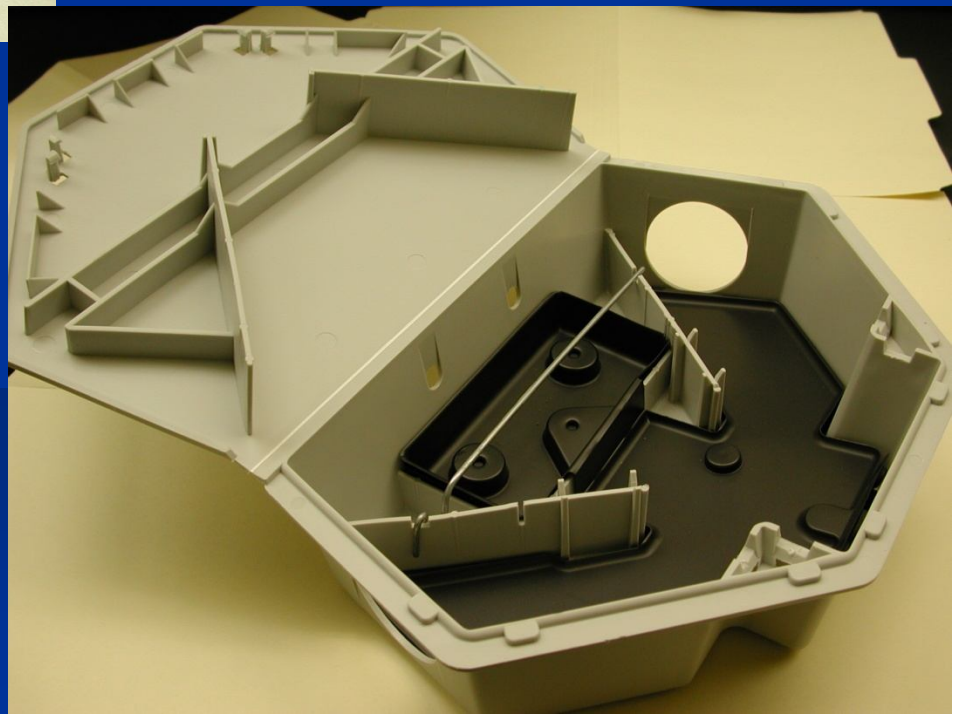
Rodenticides and Baits

- 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 D_3)


WeatherBlok® XT
RODENTICIDE
Made with TALON® Rodenticide
PRECAUTIONARY STATEMENTS
DIRECTIONS FOR USE
ZENECA
ZENECA Professional Products
WeatherBlok® XT
RODENTICIDE
Made with TALON® Rodenticide
Keep Out of Reach of Children
CAUTION
Kills warfarin-resistant Norway Rats and
Rodents may consume a lethal dose in
with first dead rodents appearing four
after treatment begins.
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
INERT INGREDIENTS
TOTAL
EPA Reg. No. 10182-339
EPA Est. No. 61282-WI-1
See side panel for additional
Net Conte
Baits

Bait Boxes





Baits-Pellets


d-CON
READY MIXED BAITBITS
KILLS MICE AND RATS
4 READY-TO-USE BAIT FILLED TRAYS
FLAVOR ATTRACTIVE TO MICE AND RATS
CAN KILL IN ONE FEEDING
Mice and rats will die within 4 or 5 days
Keep out of reach of children.
CAUTION: May be harmful or fatal if swallowed.
Read additional precautionary statements on back panel.
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
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
CAUTION: May be harmful or fatal if swallowed.
Read additional precautionary statements on back panel.
NET WT. 3 OZ. Bait Tray (85g)
d-CON READY MIXED BAITBITS

Liquid Baits

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

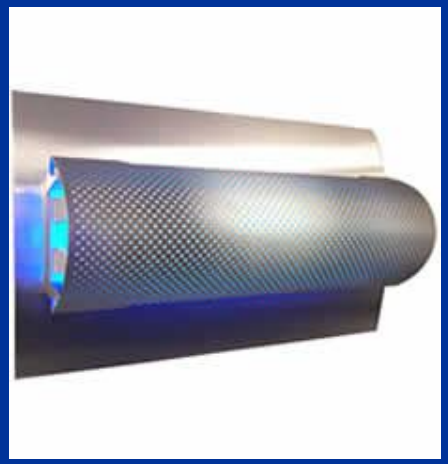
USE OF INSECT GROWTH REGULATORS – Hydroprene

USE OF BAITS - 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