

ACE Preparation: Insect Biology and Morphology

A structural and functional guide for pest management professionals.

The Arthropod Blueprint: Locating the Insecta Class

Bilaterally symmetrical
Hard outer exoskeleton
Segmented bodies
Jointed legs

Phylum Arthropoda

Class Crustacea
(Lobsters, crabs, shrimp)



Class Arachnida
(Spiders, mites, scorpions)



Class Chilopoda
(Centipedes)

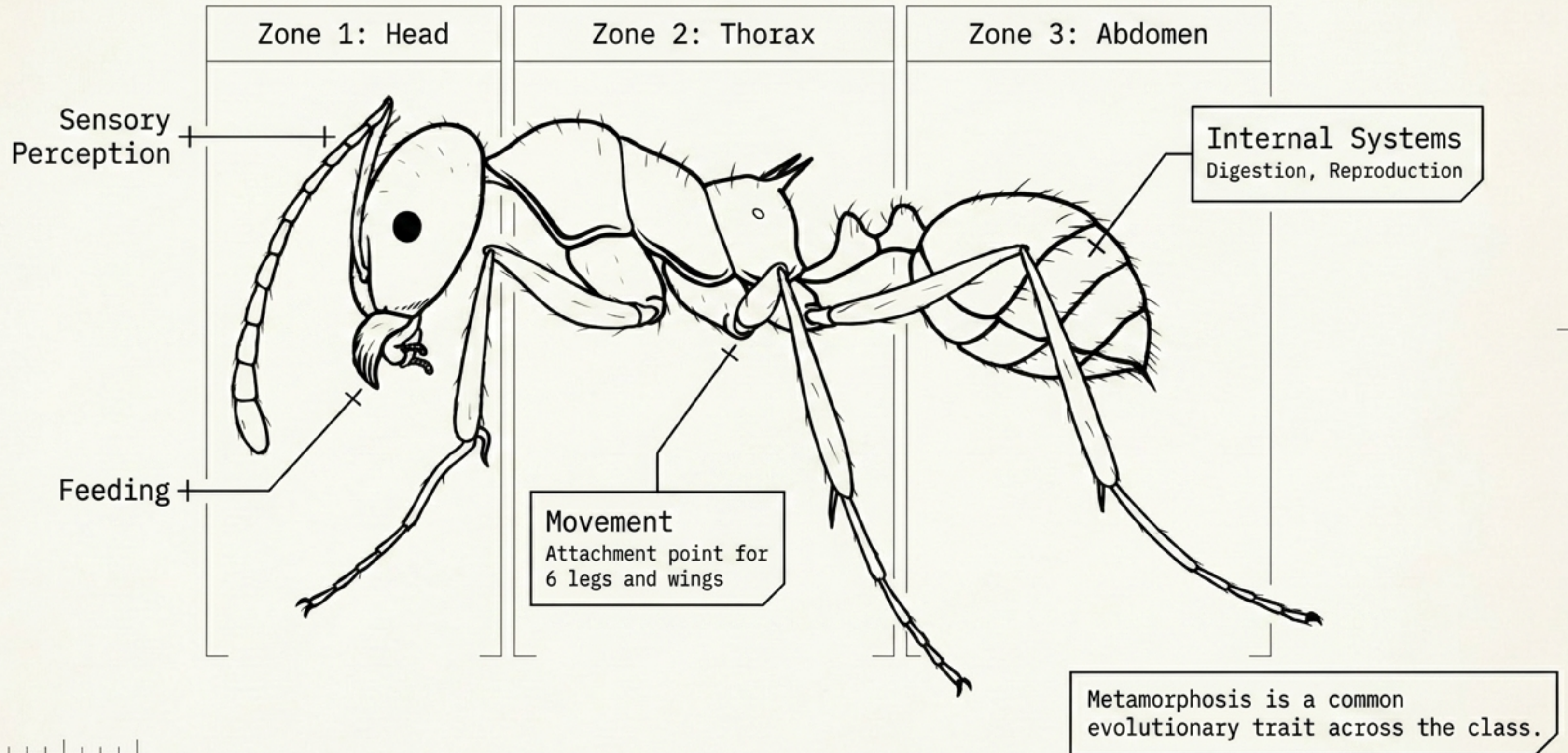


Class Diplopoda
(Millipedes)



Class Insecta / Hexapoda
(Insects)

Core Architecture: The Three-Region Functional Model



Regional Mechanics: Sensory, Locomotion, and Internal Systems

Head (Sensory Center)



- Eyes (Vision)
- Palpi (Taste, touch)
- Antennae (Smell, touch, temperature, water detection)

Thorax (Movement Center)



Wing attachment points

- Leg segments:
 - Coxa
 - Trochanter
 - Femur
 - Tibia
 - Tarsus

Abdomen (System Center)



- Digestive tract
- Communication glands (Pheromones)
- Reproductive organs (Genitalia, Ovipositor)

Exoskeleton Physiology & Physical Defenses



Biological Specs

Made of the protein chitin (strong, lightweight, resilient, ideal for small organisms).
Covered with outer wax layers for waterproofing.

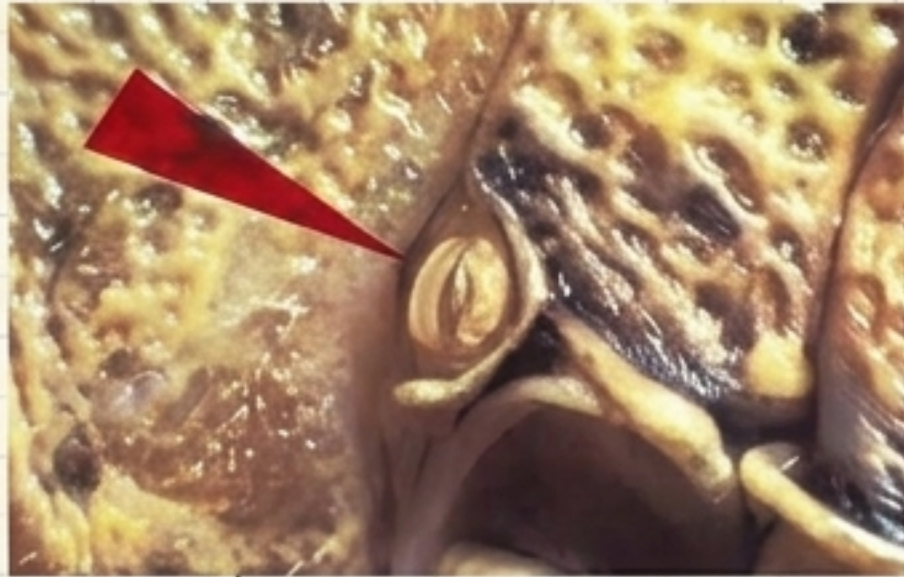
Application Matrix

Material	Mechanism	Action
Diatomaceous Earth (DE)	 Mechanism = Physical	Abrades the insect cuticle
Silica Aerogels Chemical/ Physical		Action = Absorbs waxes directly from the exoskeleton

Critical Constraint: Desiccants are only highly effective in dry environments.

The Respiratory Network: Tubes, Valves, and Asphyxiation

The Hardware



Specs: A simple series of tubes (tracheae) and exterior openings (spiracles).

The Intervention



Oil: An insecticide for all spiracles.

Mechanism: Horticultural oils (vegetable and mineral) physically block the spiracles, causing asphyxiation.

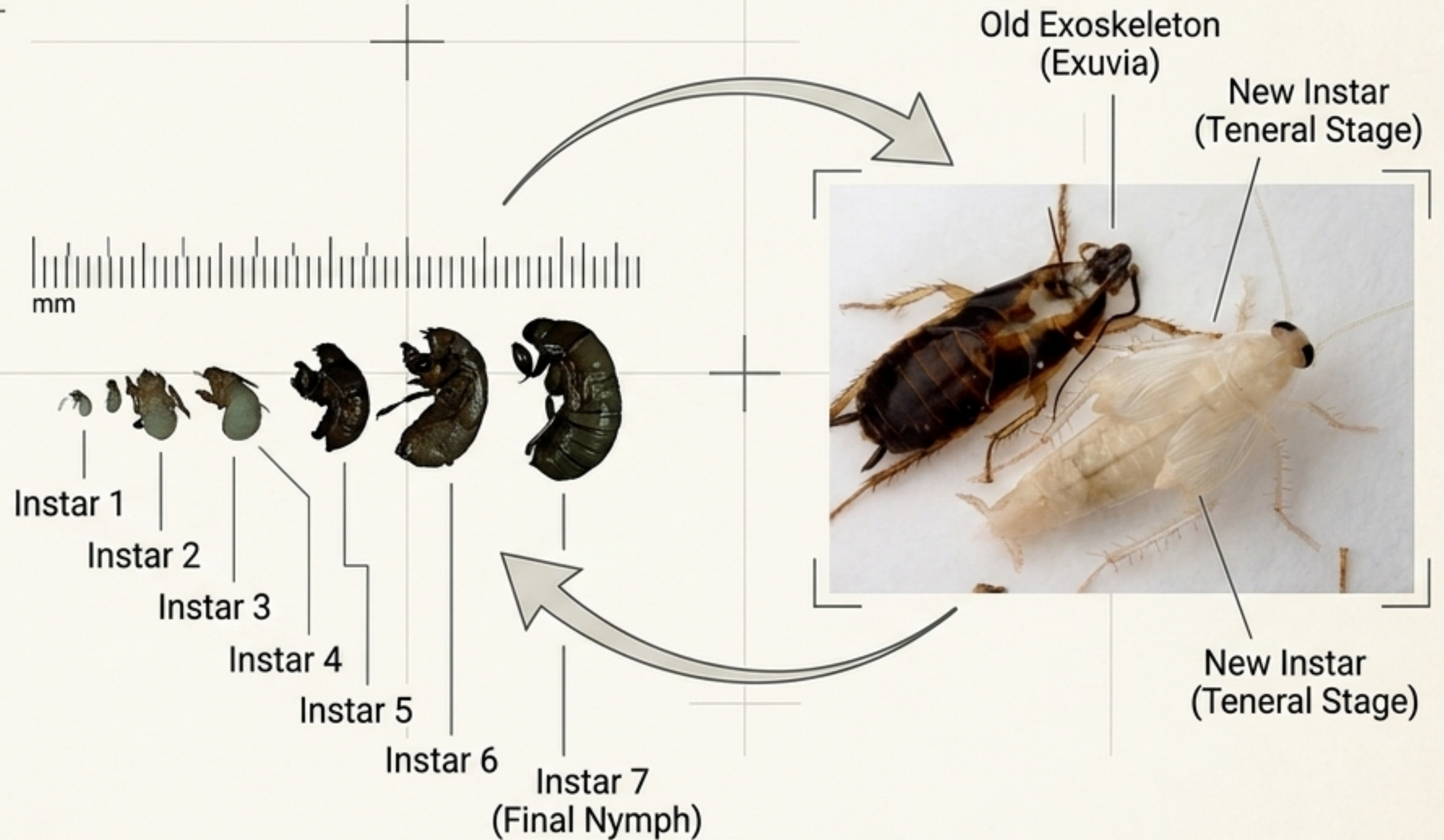
The Growth Engine: Molting and Instars

Core Concepts:

Because the rigid exoskeleton does not grow, insects must molt during immature stages.

The distinct stages between molts are called instars.

Metamorphosis (from Greek) means a change in form.



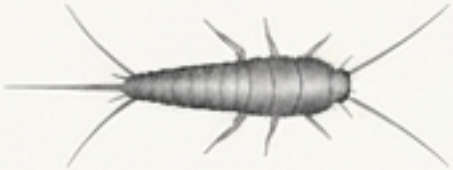
The Metamorphosis Spectrum

Path 1: None (Ametabolous)

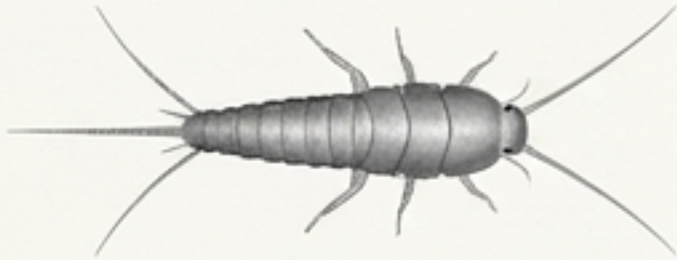
Egg



Young



Adult



Process: No distinct form change.
Key Orders: Springtails, Silverfish.

Path 2: Gradual (Paurometabolous)

Egg



Nymph



Adult

Traits: Immatures (nymphs) resemble adults. Developing wing pads visible in later instars.
Key Orders: Grasshoppers, termites, roaches.

Path 3: Complete (Holometabolous)

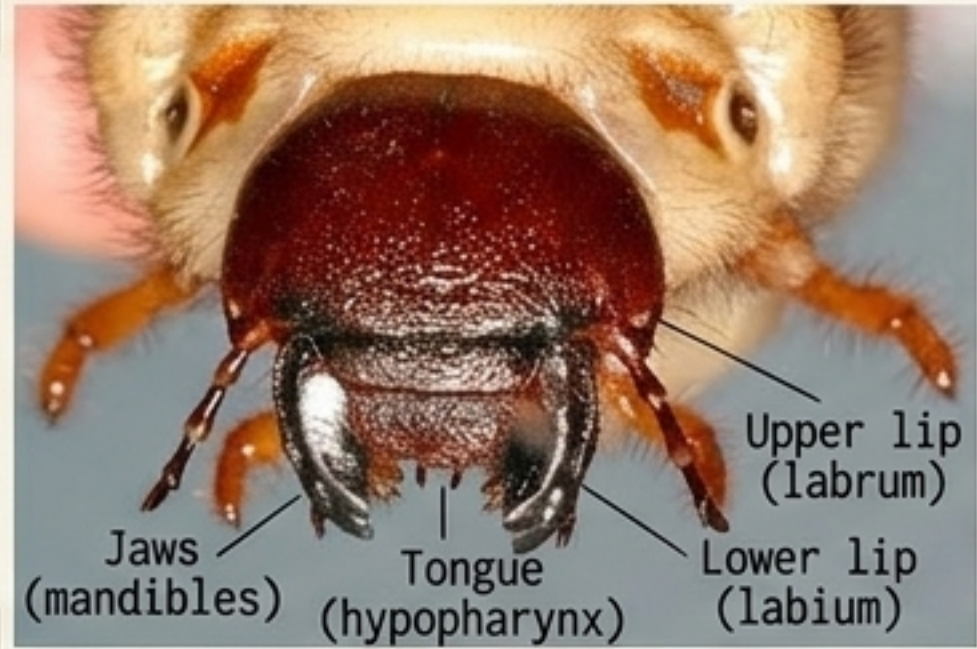
Egg



Larva

Functional Hardware: The Mouthpart Diagnostic Table

1. Chewing



Mechanics:
Side-to-side movement.

Components:
Upper lip (labrum),
Jaws (mandibles, maxillae),
Tongue (hypopharynx),
Lower lip (labium).

Orders: Crickets, termites,
beetles, caterpillars.

2. Piercing/Sucking



Mechanics:
Microscopic food channel
for liquids. Folded under
head/between legs.

Orders: Plant bugs, fleas,
lice, mites.
(Sap feeders, blood
suckers, predators).

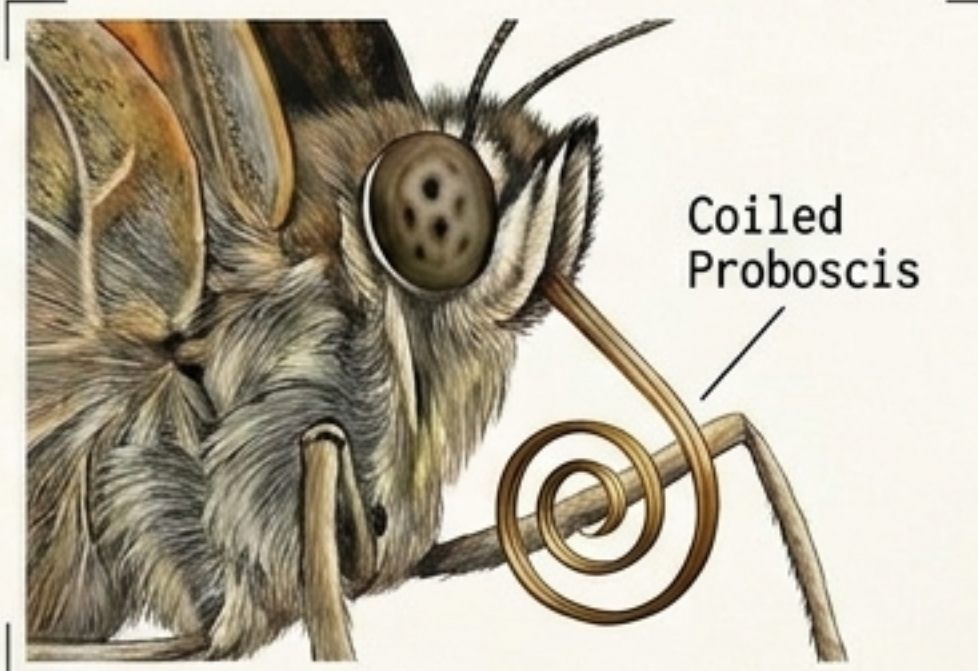
3. Sponging



Mechanics:
Sponge-like labella.
Feeds on exposed liquids.
Capable of transmitting
pathogens.

Orders: Certain flies
(House fly, blow fly).

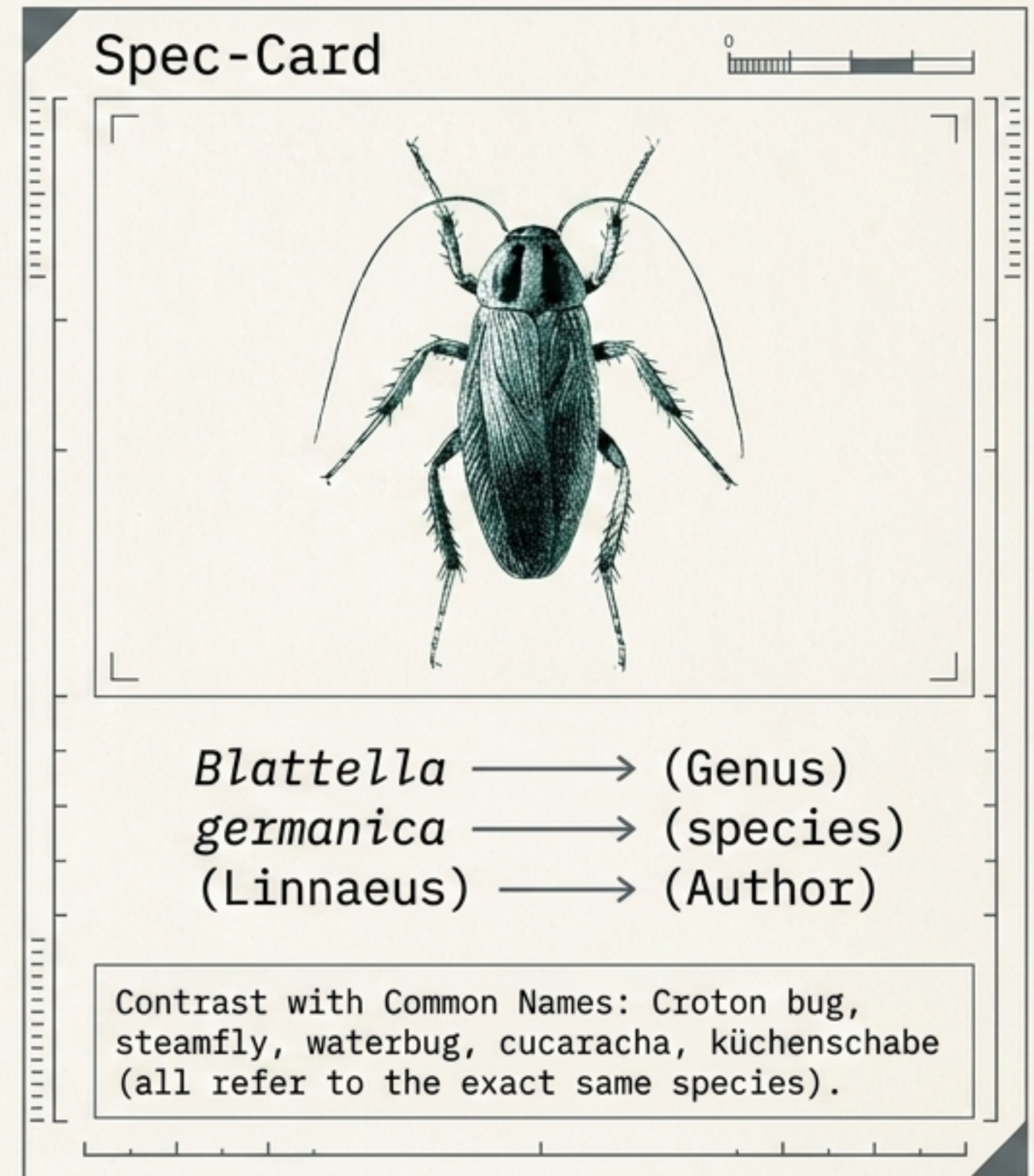
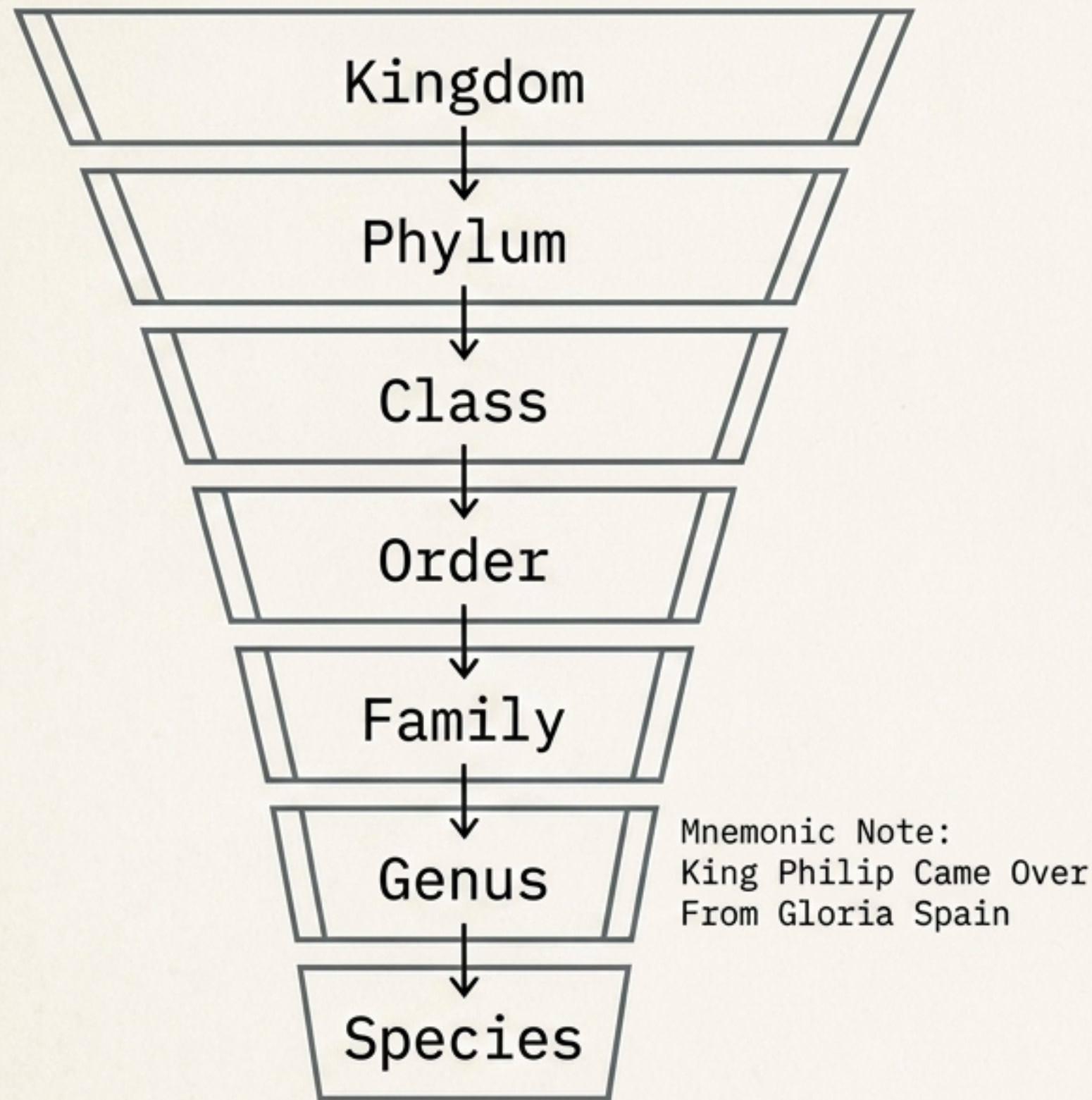
4. Siphoning



Mechanics:
Flexible maxillae form
a soda-straw-like tube.
Incapable of piercing
skin/plants.

Orders: Moths and
butterflies.

Taxonomic Classification & Nomenclature Rules



Major Orders I: Ametabolous & Early Gradual Forms

Collembola (Springtails)



Name: kolla (glue) +
embolon (bolt)

Meta: None

Mouth: Chewing

Notes: Decaying plant
feeders, very small
(0.25-0.6mm),
nuisance pests in
pools/homes.

Thysanura (Silverfish)



Name: thysan (bristle)
+ ura (tail)

Meta: None

Mouth: Chewing

Notes: 3 tail
appendages, feed on
starches/books/fabric.

Dermaptera (Earwigs)



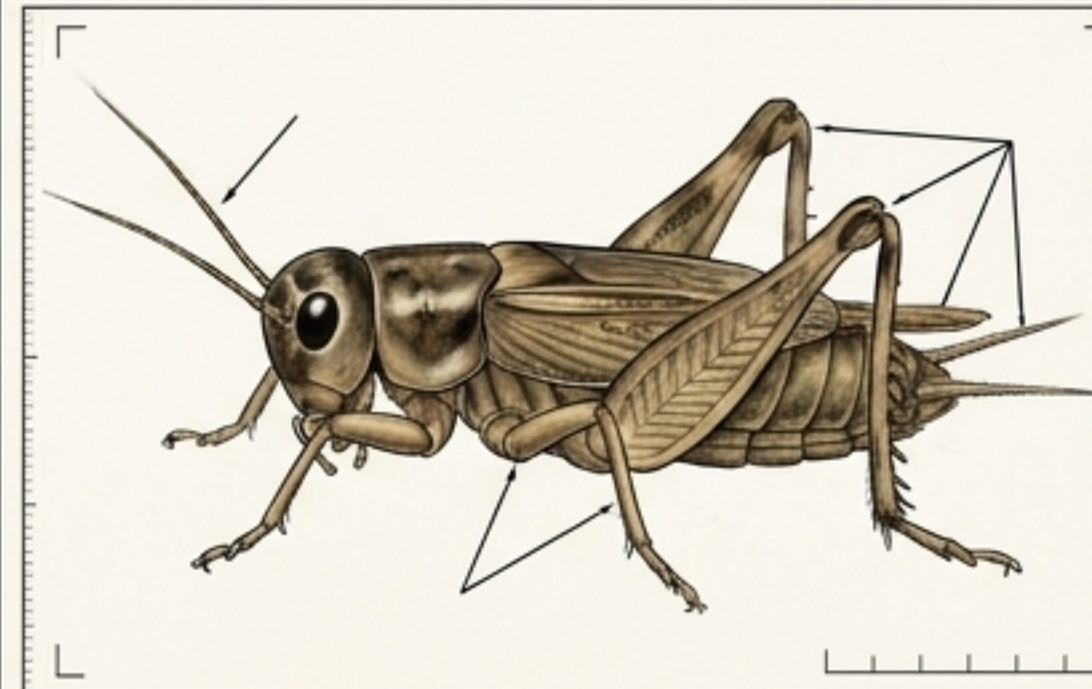
Name: derma (skin) +
ptera (winged)

Meta: Gradual

Mouth: Chewing

Notes:
Nocturnal, large
harmless pinchers.

Orthoptera (Grasshoppers/Crickets/Katydid)



Name: ortho
(straight)

Meta: Gradual

Mouth: Chewing

Notes:
Can produce sound,
plant material
feeders.

Major Orders II: Blattodea & Isoptera

Blattodea (Cockroaches)



Name: blatta (cockroach).
Specs: Gradual metamorphosis, chewing mouthparts, omnivorous.
Key Pest Note: Medium to large, mostly nocturnal. Some produce specialized egg cases called ootheca.

Isoptera (Termites)



Name: iso (equal) + ptera (winged).
Specs: Gradual metamorphosis, chewing mouthparts, feed on cellulose.
Key Pest Note: Highly social, generally small (<1cm). Rely on a symbiotic relationship with cellulose-digesting protozoans.

Major Orders III: Hemiptera (True Bugs & Relatives)

Name: hemi (half) + ptera (winged). Gradual metamorphosis. Piercing/sucking mouthparts.

Suborder Heteroptera (True Bugs)



Wing Morphology:
Only outer half of
wings are
membranous; held
flat over the
body.

Pests: Bed bugs,
stink bugs,
kissing bugs,
assassin bugs.
(Predators and
plant feeders).

Suborder Homoptera (Plant Bugs)



Wing Morphology:
Fully membranous
wings held roof-
like over the
body.



Pests: Cicadas,
aphids, scales,
mealybugs,
treehoppers.
(All plant
feeders; many
important plant
pests).

Major Orders IV: Complete Metamorphosis (Holometabolous)

Coleoptera (Beetles)



- **Name:** Coleo (sheath).
- **Mouth:** Chewing.

Notes: Most diverse order. Only 2nd pair of wings used in flight. Pests of plants, grain, wood.

Siphonaptera (Fleas)



- **Name:** siphon (tube) + aptera (wingless).
- **Mouth:** Sucking.

Notes: Parasitic, jumping. Require furred animals for survival/reproduction.

Diptera (Flies)



- **Name:** di (two).
- **Mouth:** Lapping, Piercing/Sucking.

Notes: Excellent fliers. Legless larvae usually found in wet environments.

Lepidoptera (Moths/Butterflies) & Hymenoptera (Bees/Wasps/Ants)



Lepi Notes: lepto (scale).
Siphoning mouthparts.
Scaly wings.
Fabric/stored product pests.

Hymen Notes: humen (membrane).
Chewing mouthparts.
Constriction between abdomen and gaster.
Highly social.

The Pest Management Matrix: Biology Applied



The Cuticle Constraint

Biology: Wax-covered chitin exoskeleton.



Management Protocol: Utilize desiccants (Diatomaceous Earth / Silica) to abrade or absorb wax, but only in dry environments.



The Spiracle Vulnerability

Biology: Oxygen exchange via passive spiracle valves.

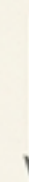


Management Protocol: Utilize physical asphyxiants (Horticultural oils) for soft-bodied pests.



The Metamorphosis Multiplier

Biology: Complete metamorphosis creates distinct biological life stages (Larva vs. Adult).



Management Protocol: PMPs must treat entirely different habitats and food sources simultaneously (e.g., treating pet fur for adult fleas via sucking mouthparts, while treating carpets for larval fleas via chewing mouthparts).