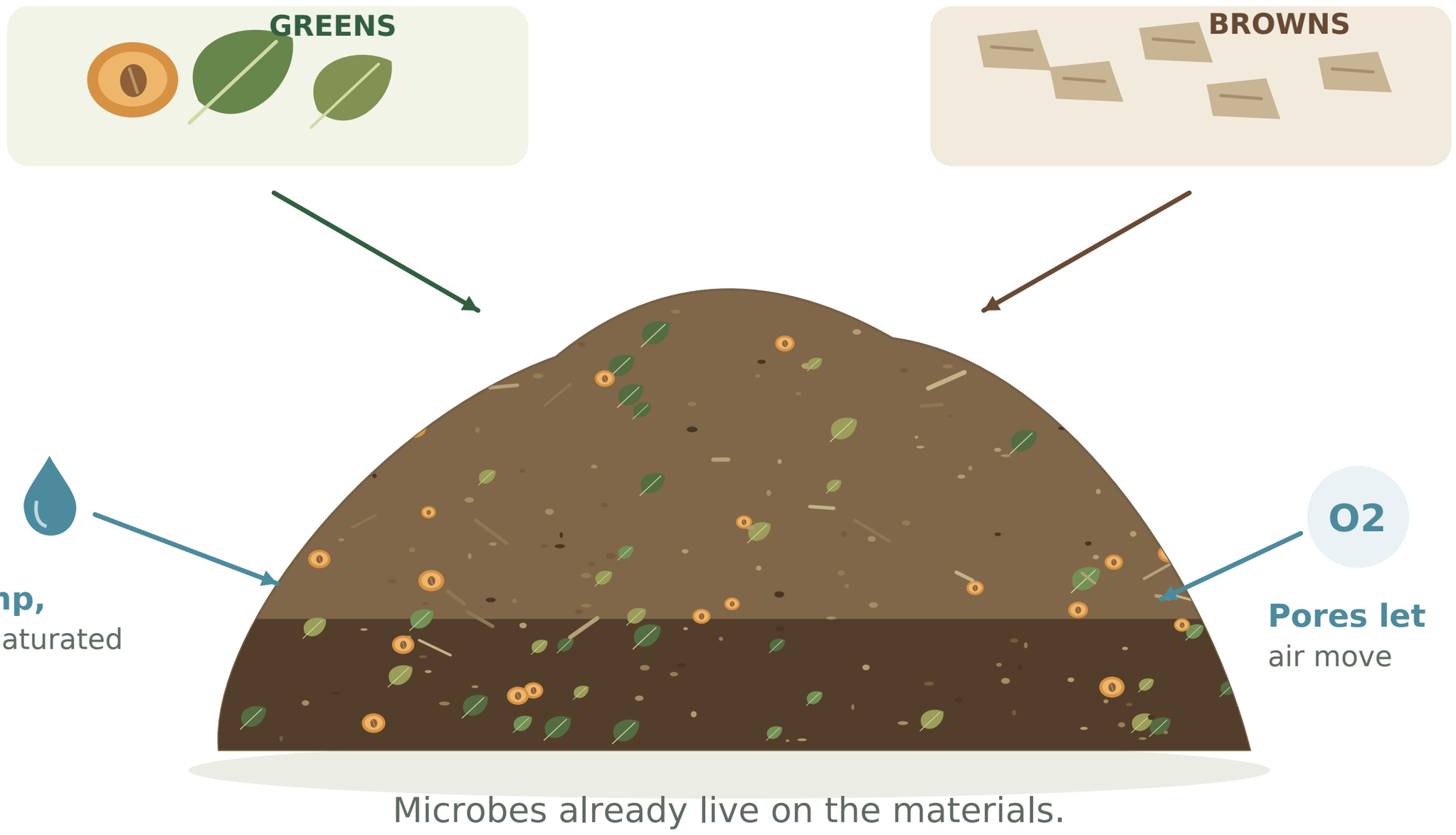
1 Build a breathable mix

Start with permitted green waste and suitable dry bulking material.



Microbes already live on the materials.

WHAT IS HAPPENING AT THIS STAGE

Fresh plant matter contains easily used food and tougher plant fibres. Mixing moist greens with suitable dry, coarser material creates air spaces and gives microbes the conditions they need to start breaking the material down.

FOOD FOR MICROBES

Fruit flesh and tender greens provide water, carbon and nutrients. Dry leaves, paper and suitable woody pieces add carbon and help the mix retain structure.

WHY WATER MATTERS

Moisture helps dissolved food and enzymes move between microbes and organic particles. Too much water fills air spaces; too little slows microbial activity.

WHY AIR MATTERS

Microbes consume oxygen as they work. Open pores let more air enter. Wet, compressed clumps restrict that resupply and can become oxygen-poor.

VINEGAR-FLY JOURNEY

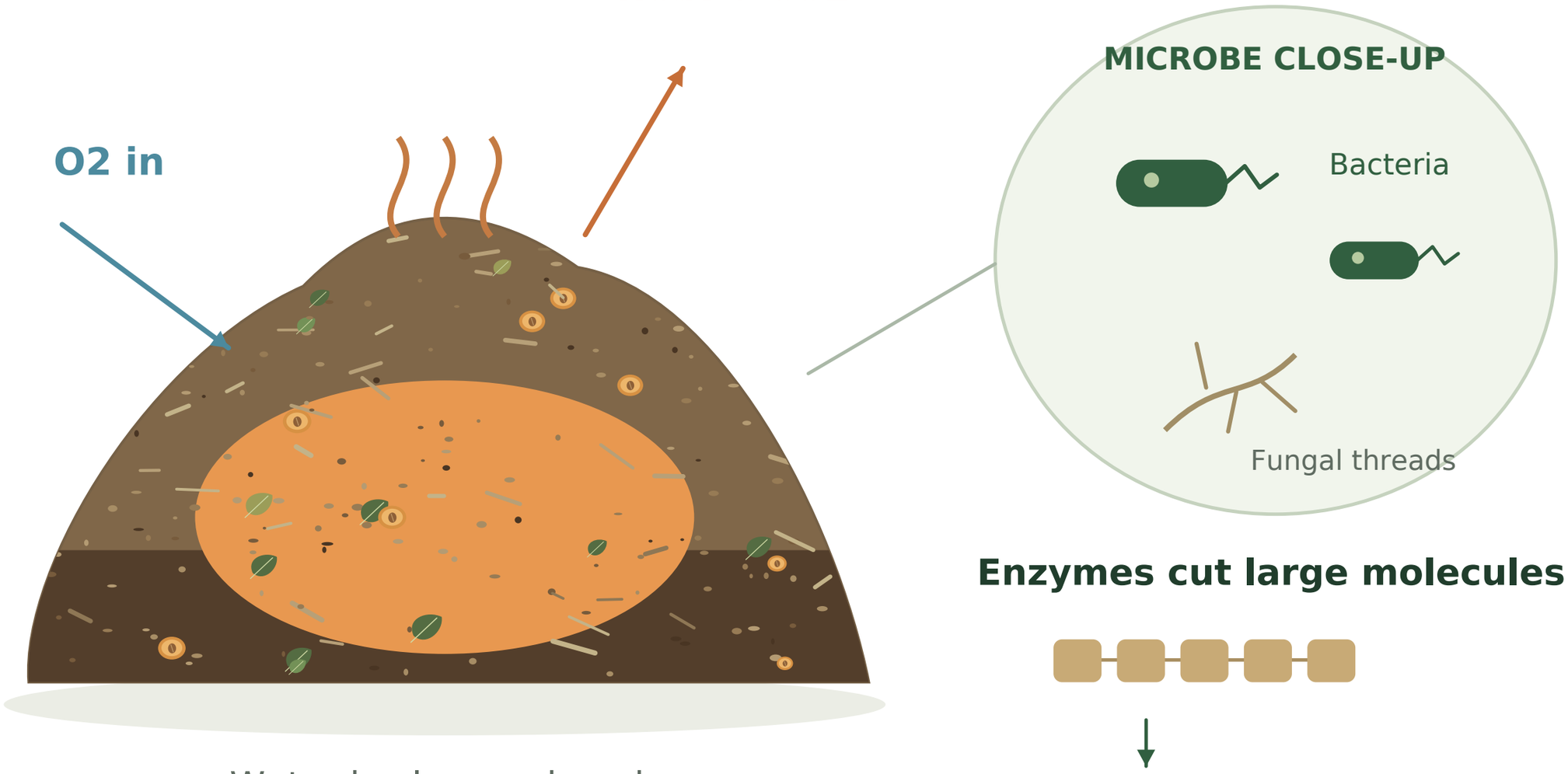


Vinegar flies can be attracted to fermenting fruit and lay eggs on moist, exposed food. Microbes are already present on the waste; flies are not needed to start the heating process.

Next: microbes begin using the easiest food.

2 Microbes generate the heat

The early warming phase begins with biological activity.



Water is also produced.

WHAT IS HAPPENING AT THIS STAGE

Microbes consume easy food such as sugars. They also release enzymes that split larger organic molecules into smaller pieces. Their respiration releases heat: the pile warms when it retains more heat than it loses.

ENZYMES OPEN FOOD

Bacteria and fungi release enzymes outside their cells. These break large molecules into smaller pieces that microbes can use for growth and energy.

RESPIRATION MAKES HEAT

Aerobic microbes use oxygen while consuming organic matter. Carbon dioxide, water and heat are released. Some carbon also becomes new microbial cells.

WHY THE PILE WARMS

A suitable pile retains part of the biological heat. Its size, structure, moisture and airflow affect the balance between heat production and heat loss.

VINEGAR-FLY JOURNEY

Where conditions remain suitable, eggs can hatch into larvae. The larvae feed on microbes, including yeasts, and softened organic material. They do not create the hot-composting phase.

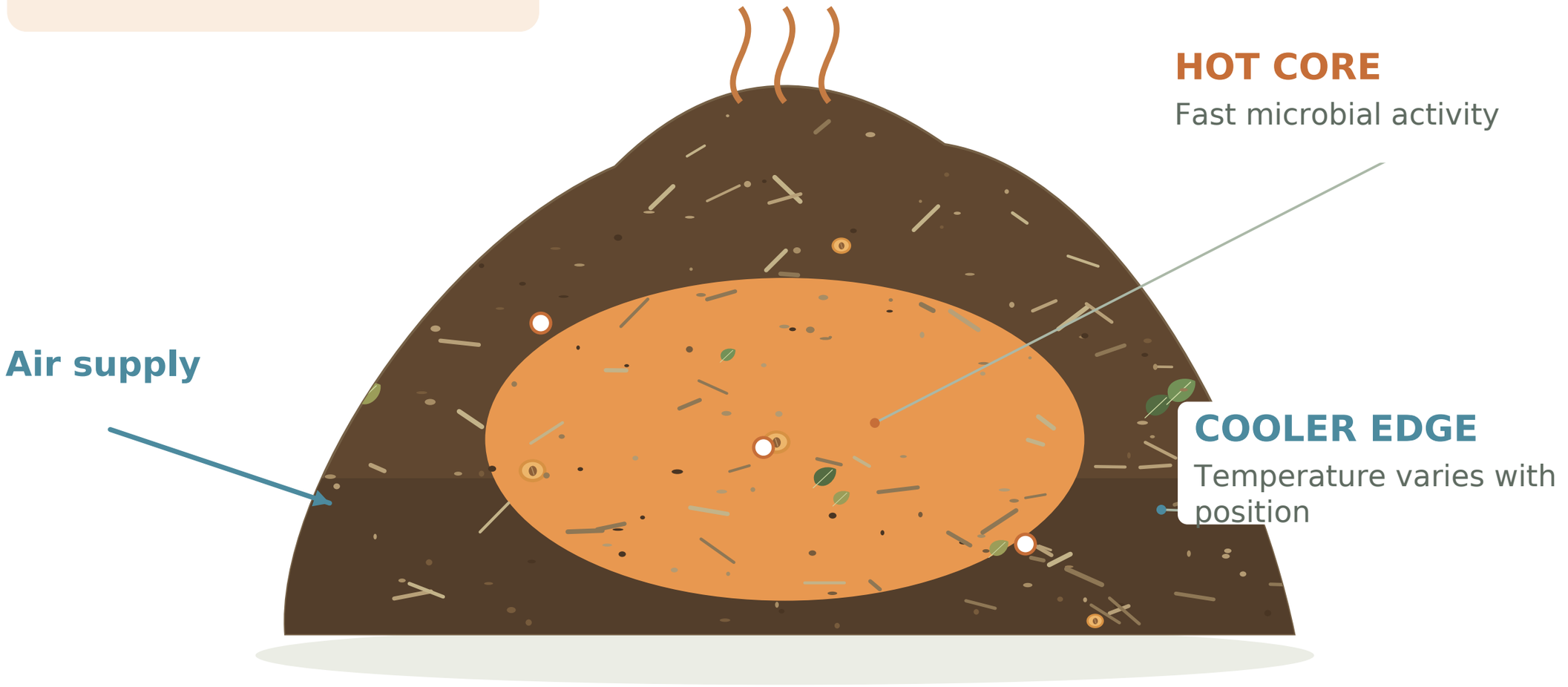
Next: heat-tolerant microbial groups become more active.

3 The hot phase develops

A warm core and cooler outer material can exist in the same pile.

Typical hot-zone example

55-65°C



Measure several positions and record time at temperature.

WHAT IS HAPPENING AT THIS STAGE

As the pile warms, conditions favour microbes that tolerate higher temperatures. Their enzymes continue breaking down soft tissues and some plant-cell-wall fibres. Oxygen, moisture and accessible food still control how much work they can do.

THE WORKERS CHANGE

Heat-tolerant bacteria and some fungi remain active as conditions change. The microbial community shifts; the hottest zone does not suit every decomposer.

THE MATERIAL SOFTENS

Soft plant tissues lose structure and some fibres begin to break down. Lignin-rich twigs and wood usually persist longer than fruit flesh and tender leaves.

EXPOSURE IS UNEVEN

The core can be hot while outer material stays cooler. Temperature, time and location all matter. One peak reading does not prove the entire batch was treated.

VINEGAR-FLY JOURNEY

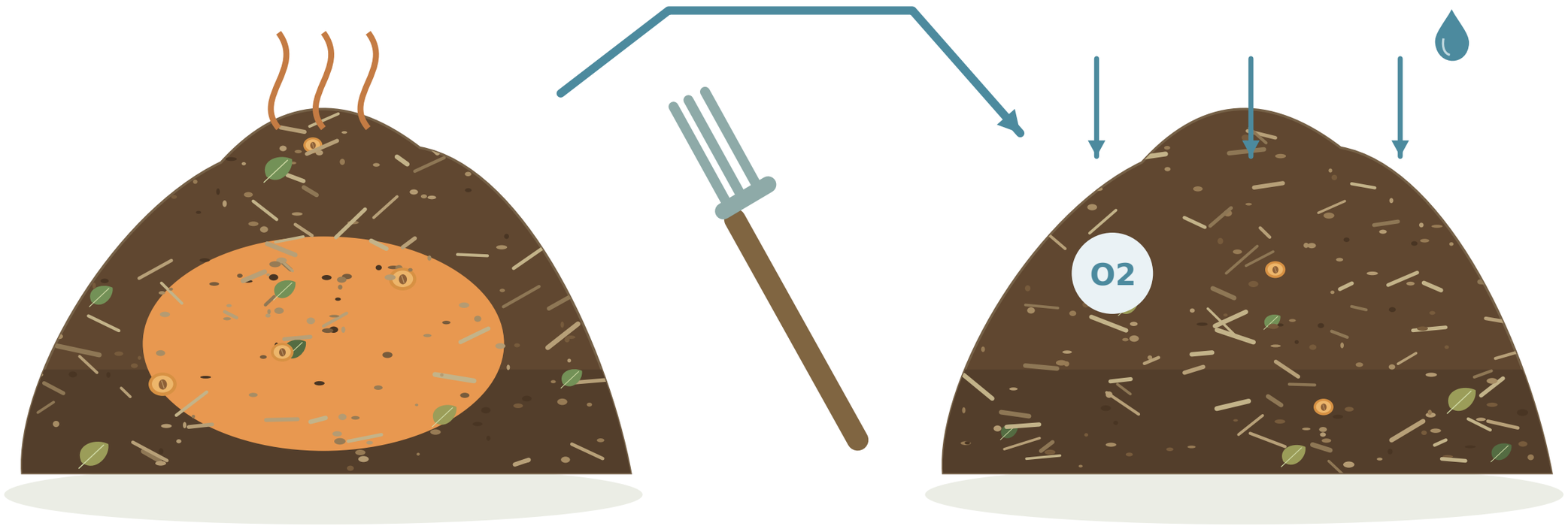
Immature flies exposed to enough heat for long enough can die. Those in cooler pockets may survive, and adults can leave. A hot centre alone does not establish pest eradication.

Next: redistribute the material and restore the conditions.

4 Turn, mix and adjust

Move outer material inward and rebuild a porous, evenly damp pile.

Move outer material inward



Temperature may drop briefly as heat escapes.

WHAT IS HAPPENING AT THIS STAGE

Turning breaks up compacted pockets and redistributes the material. Cooler, less-decomposed outer material can move into the active interior. Temperature may fall briefly because mixing releases trapped heat and combines warmer and cooler material.

REOPEN AIR PATHWAYS

Fresh air enters spaces opened by mixing. A porous structure helps oxygen keep reaching microbes after the pile is rebuilt, rather than compacting again.

EVEN OUT MOISTURE

Mix dry and wet patches, then add water only where needed. Excess water can fill air spaces, so watering is not automatic after every turn.

MAKE MORE FOOD ACCESSIBLE

Moving less-processed material into active areas gives microbes access to more food. Renewed respiration can then reheat the rebuilt pile if conditions are suitable.

VINEGAR-FLY JOURNEY

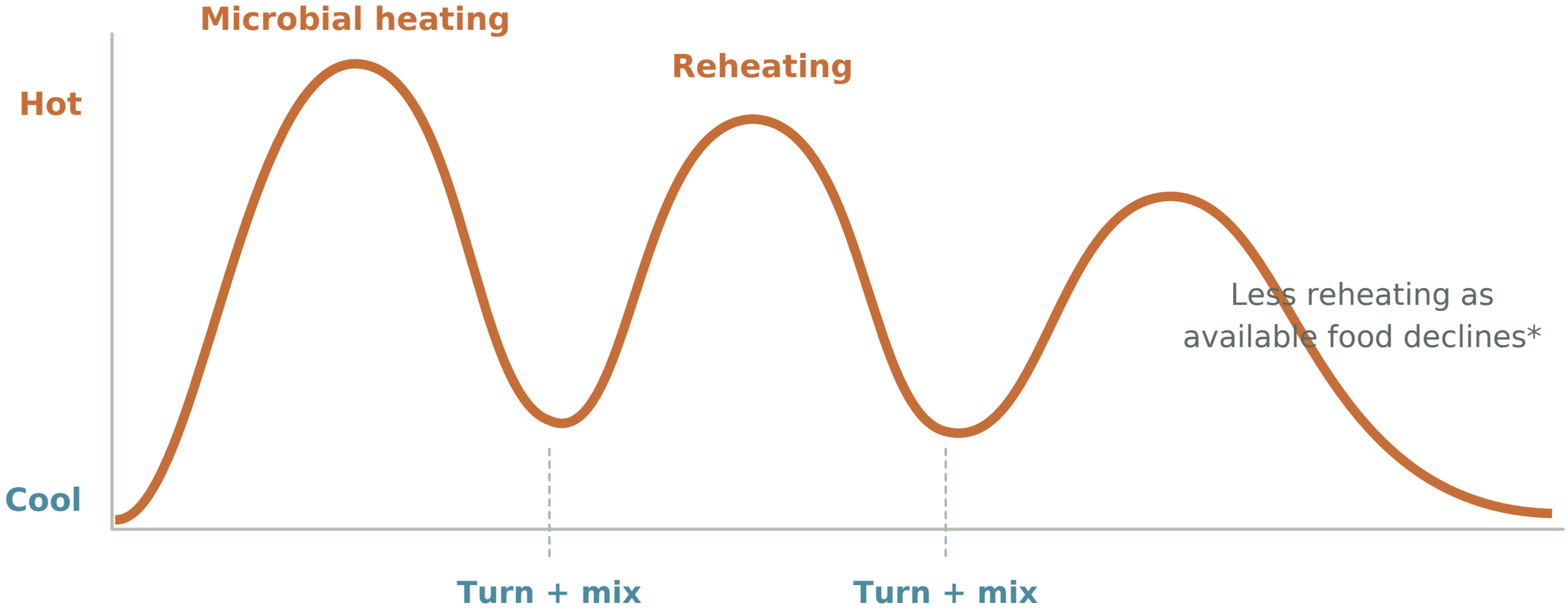
Turning can move immature stages into hotter material, but moving larvae may reach cooler refuges. Later larvae can leave wet food and seek a place to pupate; they need not remain where they first fed.

Next: rebuild and watch whether the pile reheats.

5 Reheat, reassess, repeat

Repeated heating reflects renewed microbial activity, not an automatic recipe.

ILLUSTRATIVE PATTERN - NOT FARM MEASUREMENTS



*Check moisture and aeration before interpreting a cool pile.

There is no universal number of cycles.

WHAT IS HAPPENING AT THIS STAGE

After rebuilding, microbes can use newly accessible food and oxygen to produce another heat pulse. More readily used material is consumed with each active round. Reheating may eventually weaken, provided moisture and airflow remain adequate.

WHY IT REHEATS

Mixing exposes less-processed material and improves access to air. Microbes resume active respiration when enough usable food, moisture and oxygen are available.

WHY IT CAN COOL

Less available food is one explanation. Dryness, waterlogging, poor airflow or heat loss can also cool the pile. Check these before calling the material finished.

WHY RECORDS MATTER

Track temperature at several positions and over time. There is no universal number of turns that proves maturity or sanitation. New feed changes the batch exposure history.

VINEGAR-FLY JOURNEY

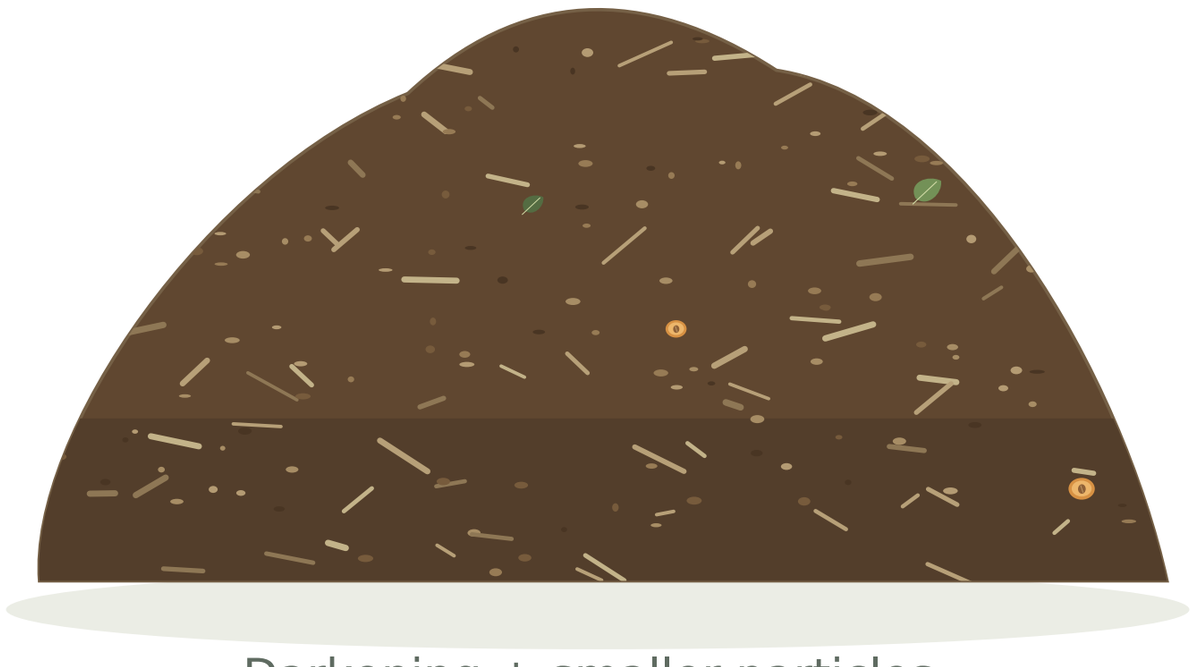
Repeated mixing can improve heat exposure, but cycle count alone does not prove every insect died. Cooling is not a kill step. Survivors in cooler areas can still continue their life cycle.

Next: allow the material to cool and stabilise.

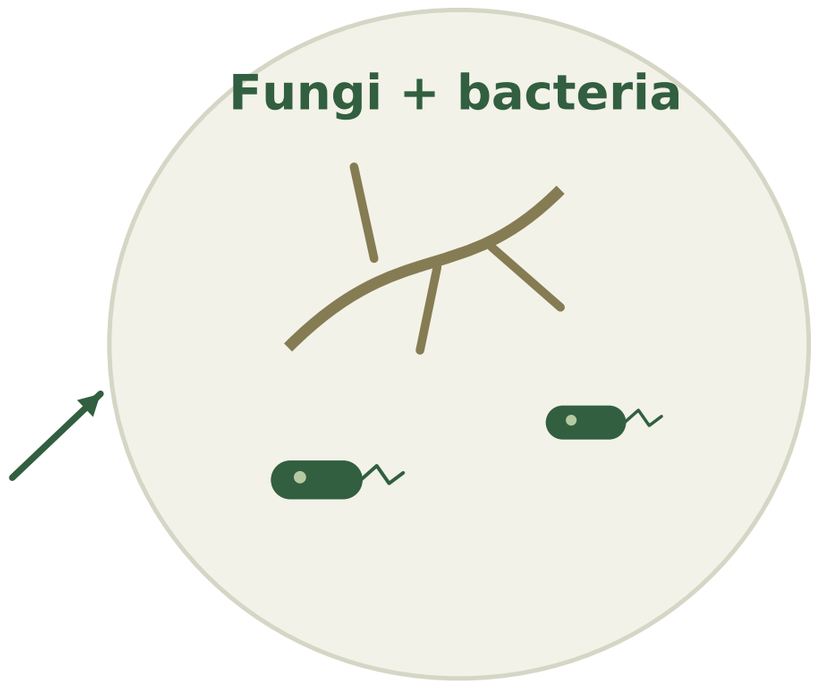
6 Cool and stabilise

Slower decomposition continues as available food and microbial activity change.

COOLED, PARTLY STABILISED MATERIAL



Darkening + smaller particles



continue working on fibres

Woodier pieces can remain: lignin breaks down slowly.

WHAT IS HAPPENING AT THIS STAGE

As readily used food becomes less available, microbial heat production declines. Fungi and bacteria keep working on remaining fibres. Smaller plant particles, living microbes and microbial residues contribute to the developing compost.

FIBRES KEEP CHANGING

Fungi and bacteria, including filamentous bacteria called actinomycetes, continue decomposition. Lignin-rich woody fragments may remain because they usually break down more slowly.

CARBON AND NUTRIENTS

Respiration releases carbon as CO2 and the material loses mass. Nutrient forms change, and some nitrogen can be lost. Composting does not manufacture new nutrients.

CHECK FOR REHEATING

Correct moisture and aeration, then assess renewed heating. Cool temperature and dark colour alone cannot establish stability, pathogen reduction or suitability as worm feed.

VINEGAR-FLY JOURNEY

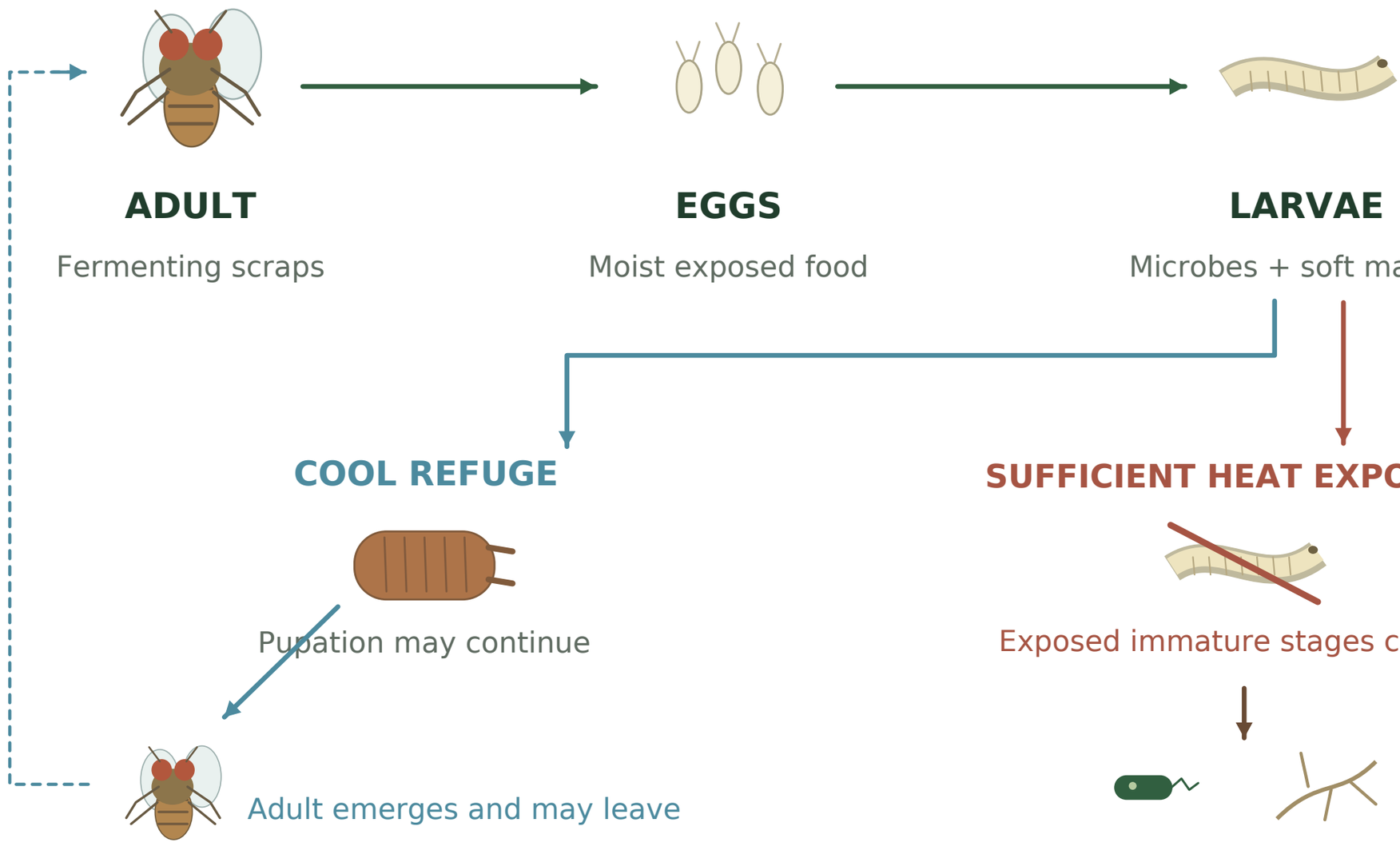
Microbes also break down dead insects and cast-off skins. Their material joins the decomposing organic matter. New flies can colonise suitable exposed food after the pile has cooled.

Detour: follow the fly life cycle, then prepare worm feed.

7 Follow the fly: two outcomes

A vinegar-fly example. This does not identify any insect on your farm.

COMMON VINEGAR FLY (DROSOPHILA) - AN EXAMPLE



WHAT IS HAPPENING AT THIS STAGE

Vinegar flies can develop around exposed fermenting food. Their larvae use microbes and softened material, but do not drive hot composting. Heat exposure and access to cooler refuges can lead to very different outcomes.

EGGS BECOME LARVAE

Adults lay eggs on suitable moist food. Where conditions allow, eggs hatch and larvae feed and grow in microbe-rich material. Timing varies with conditions.

A COOL REFUGE

Mature larvae may leave wet food and pupate elsewhere. If that stage avoids lethal conditions, an adult can emerge, fly away and potentially lay more eggs.

SUFFICIENT HEAT

Enough heat for long enough can cause death of exposed immature stages. The dose varies by species and stage. Survivors can remain in cooler parts of a pile.



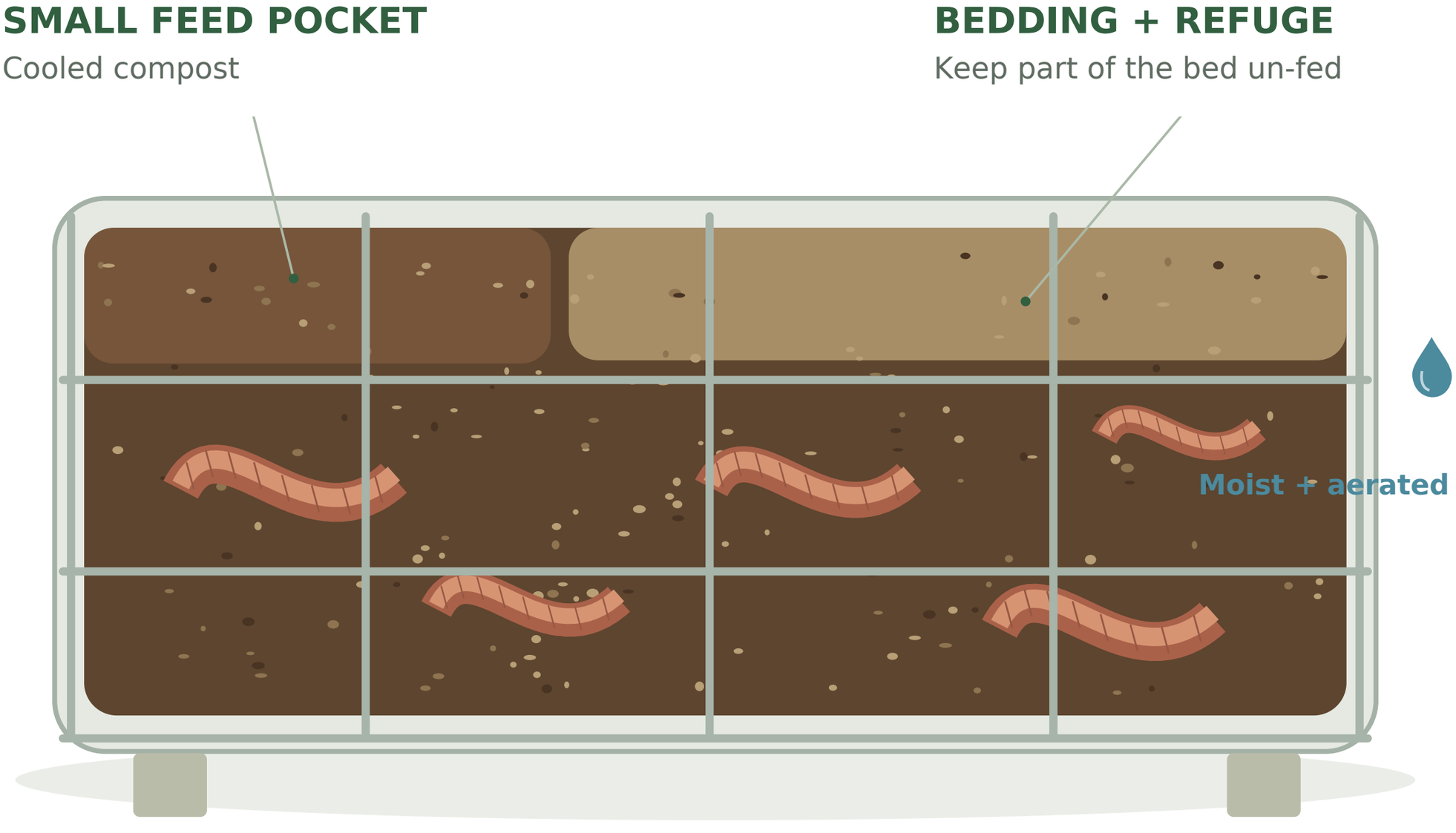
DIFFERENT FLIES: DIFFERENT HANDLING

These illustrations use vinegar flies. In the Riverland, suspected pest-infested produce must not be home-composted: double-bag it and contact PIRSA. Commercial loads must follow applicable PIRSA directions.

Heat exposure can interrupt the life cycle; cool refuges can allow survival.

8 Cooled compost becomes worm food

This is a pre-compost-to-worm pathway: worms continue the processing.



Worms + microbes continue processing the prepared feed.

WHAT IS HAPPENING AT THIS STAGE

Prepared feed still contains organic matter and microbes. Worms ingest microbe-colonised material, fragment it and pass it through their gut. Microbial breakdown continues in the bed as the material is transformed further into castings.

COOL BEFORE FEEDING

Check inside the feed after mixing. Keep actively heating material out of the worm bed. A small trial can also reveal whether the feed starts heating again.

START WITH A SMALL POCKET

Place a small amount beside established moist bedding and leave a refuge. Observe worm acceptance, avoidance, heating and strong odours before adding more.

THE WORMS CONTINUE

Microbes have already done part of the breakdown. Worms and microbes continue processing it. Longer pre-composting is not automatically better; feed preparation must match the material.



VINEGAR-FLY JOURNEY

Cooled feed can be visited again by flies. Manage incoming scraps and exposed feed to limit access. Neither cooling nor worm acceptance demonstrates pest freedom or microbiological safety.

Final destination: prepared, cooled feed for the worm farm.

Evidence notes 1/2

Original studies underpin the process. Application to RBW remains feedstock-specific.

1 **Yeh et al. (2020)**

Optimizing Food Waste Composting Parameters and Evaluating Heat Generation. Applied Sciences 10, 2284.

doi.org/10.3390/app10072284

Food waste, not an RBW apricot recipe. Moisture, structure and aeration affected heating. The reported optimum is specific to that study.

2 **Antunes et al. (2016)**

Microbial community structure and dynamics in thermophilic composting viewed through metagenomics and metatranscriptomics. Scientific Reports 6, 38915.

doi.org/10.1038/srep38915

Turning altered access to oxygen and substrate and changed the microbial community. Results came from a large composting operation; they do not prescribe a turning calendar.

3 **López et al. (2021)**

Characterization of Thermophilic Lignocellulolytic Microorganisms in Composting. Frontiers in Microbiology 12, 697480.

doi.org/10.3389/fmicb.2021.697480

One plant-waste system degraded 58% of cellulose plus hemicellulose, but only 7% of lignin by the end. These are not expected RBW conversion percentages.

4 **Zhang et al. (2022)**

Study on dynamic changes of microbial community and lignocellulose transformation mechanism during green waste composting. Engineering in Life Sciences 22, 376-390.

doi.org/10.1002/elsc.202100102

Supports changing microbial communities and continuing material transformation during warming, heating, cooling and maturation. The organisms and rates vary with feedstock.

5 **Feder, Blair & Figueras (1997)**

Natural thermal stress and heat-shock protein expression in Drosophila larvae and pupae. Functional Ecology 11, 90-100.

doi.org/10.1046/j.1365-2435.1997.00060.x

Laboratory larval median lethal times were 30 min at 39°C, 15 min at 40°C and 8.5 min at 41°C. These are 50% mortality results, not eradication schedules, compost approvals or Queensland fruit-fly treatment requirements.

Evidence notes 2/2

Original studies underpin the process. Application to RBW remains feedstock-specific.

6 **Jiménez-Padilla et al. (2024)**

Live yeasts accelerate Drosophila melanogaster larval development. Journal of Experimental Biology 227, jeb247932.

doi.org/10.1242/jeb.247932

Supports the importance of live yeasts to larval development. Insect feeding is a secondary contribution; microbial activity drives hot composting.

7 **Kendra et al. (2007)**

Residential composting of infested fruit: A potential pathway for spread of Anastrepha fruit flies (Diptera: Tephritidae). Florida Entomologist 90, 314-320.

doi.org/10.1653/0015-4040(2007)90%5B314:RCOIFA%5D2.0.CO;2

Residential piles allowed some adult emergence. This involved Caribbean fruit fly in Florida, not Queensland fruit fly in South Australia. It supports caution about cooler refuges, not a local treatment claim.

8 **Casares, Carracedo & García-Florez (1997)**

Analysis of larval behaviours underlying the pupation height phenotype in Drosophila simulans and D. melanogaster. Genetics Selection Evolution 29, 589-600.

doi.org/10.1186/1297-9686-29-5-589

Larval movement and pupation-site choice depend on the environment and genetic background. A larva is not guaranteed to remain where it first fed.

9 **Nair, Sekiozoic & Anda (2006)**

Effect of pre-composting on vermicomposting of kitchen waste. Bioresource Technology 97, 2091-2095.

doi.org/10.1016/j.biortech.2005.09.020

Nine days of pre-composting benefited their particular kitchen-waste mix. This is not a fixed timetable or sanitation claim for other feedstocks.

10 **Mupondi, Mnkeni & Muchaonyerwa (2011)**

Effects of a precomposting step on the vermicomposting of dairy manure-waste paper mixtures. Waste Management & Research.

doi.org/10.1177/0734242X10363142

Longer pre-composting reduced microbial and soluble carbon and could reduce worm growth in that manure-paper mix. More heating and ageing are not automatically better worm-feed preparation.

11 **PIRSA (current guidance, checked 29 November 2026)**

Disposing of fruit and vegetable waste at home; commercial waste guidance during an outbreak. Official South Australian instructions, separate from the journal evidence.

fruitfly.sa.gov.au/residents/disposing-of-fruit-and-vegetable-waste-at-home

Suspected affected produce in the Riverland must not be home-composted. Commercial fruit waste may be subject to specific plans and directions. Check current location and load requirements before collection or treatment.

Commercial PIRSA guidance (click)