The Diapause Manual

Why almost everything the hobby teaches about ant hibernation has the causation backwards, and what to do instead

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Six years of keeping. Four winters of getting it wrong.

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The Diapause Manual: Why almost everything the hobby teaches about ant hibernation has the causation backwards, and what to do instead.

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On sourcing. This book separates three kinds of claim, and it labels them. Claims drawn from peer-reviewed literature carry a numbered citation to the reference list at the back. Claims drawn from my own colonies are marked as keeper observation and carry no scientific weight beyond one keeper's records. Claims that represent common hobby practice without published support are labeled *hobby practice, unverified*. If a number in this book is not cited, it is not from the literature, and you should treat it as a starting point rather than a fact.

On what is not known. Ant diapause has been studied properly in perhaps two dozen species out of more than 14,000. Most of that work covers *Myrmica*, *Lasius*, *Formica*, *Leptothorax*, and a handful of others, nearly all Palearctic. For most North American species you keep, no published diapause protocol exists. This book tells you that plainly rather than inventing numbers to fill the gap.

Not veterinary or professional advice. Check your state and federal regulations before acquiring, transporting, or keeping any ant species. In the United States, interstate movement of live ants is regulated by USDA APHIS.

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PREFACE

Two guides, two answers

The largest ant-keeping forum in the English-speaking world has two pinned diapause guides. They have almost identical traffic. They do not agree.

On Formiculture, the busiest English-language ant forum, two guides sit pinned to the top of the General Ant Keeping section. One is called the Official Guide to Hibernation, posted in 2016. The other is Ant Basics: Hibernation/Diapause, posted in 2021. As of this writing they have roughly 33,700 and 33,200 views respectively. Call it 67,000 pairs of eyes.

They disagree. Not on trivia. On the mechanism.

That should bother you more than it does. Two documents, near-identical readership, sitting six inches apart on the same page, giving different accounts of what diapause is and how to trigger it. Nobody reconciled them. Nobody had to. In a hobby, the pinned post is the truth, and if there are two pinned posts, there are two truths.

I spent four winters following that advice. I killed colonies. Not dramatically, and not all at once, which is the part that took me years to understand. A colony that dies in diapause rarely dies in diapause. It comes out in March looking thin, the queen lays a small batch, the workers die off faster than they are replaced, and by July you have a queen sitting alone in a nest that used to hold two hundred ants. You do not write that up as a diapause failure. You write it up as a bad year.

Then I went and read the literature, and found that a Russian myrmecologist named Vladilen Kipyatkov had spent roughly thirty years at St. Petersburg State University answering the exact questions the forum was arguing about. His work is dense, much of it published in Russian journals and translated into English at a lag, and almost none of it has ever been cited in a hobby guide.

The hobby thinks cold causes diapause.
For many species, it does not.

Here is the short version of what he found, and it is the reason this book exists. For a large number of temperate ants, diapause is not triggered by cold. It is not triggered by short days. It is triggered by an internal clock that runs whether you like it or not. Kipyatkov's group described these as endogenous-heterodynamic cycles: the colony stops developing on schedule even when held under long days and warm, optimal temperatures.[1,2] No environmental condition prevents it.

Read that again, because it inverts the standard advice. You are told: cool your ants down to put them into diapause. But if the diapause is endogenous, the colony was going into diapause regardless. The cooling is not the trigger. The cooling is what lets them survive the diapause they were already entering, and, in some species, what lets them come out of it correctly.

Get that backwards and you make a specific, predictable mistake. You wait for signs of slowdown before you start cooling. The colony has already been in diapause for weeks, burning reserves at a warm-temperature metabolic rate, in a state where it cannot replace them. By the time you put it in the fridge you have already spent the fuel it needed for February.

That is the failure this book is about.

What this book is not

It is not a beginner's guide to ant keeping. It assumes you have a colony, you know what a test tube setup is, and you can tell a larva from a pupa.

It is not a complete species catalogue. Chapter 16 is a blunt accounting of how little the literature actually covers, and I would rather hand you an honest gap than a fabricated table.

It is not a translation of forum consensus into nicer paragraphs. Where the hobby and the literature disagree, I say so, I cite the literature, and I tell you where the literature itself is thin.

How to read it

Part I is the science, and it is the part that changes your behavior. If you read nothing else, read Chapters 2 and 5. Part II is diagnosis. Part III is the protocol, month by month. Part IV is species, including the honest gaps. Part V is the autopsy index: symptoms, causes, and whether it was recoverable.

Every number that came from a paper has a citation. Every number that came from my colonies is labeled as mine. Every number that is hobby folklore with no published basis is labeled as folklore. That labeling is the most useful thing in this book, and it is the thing no other diapause guide does.

PART ONE

The Science You Were Not Told

Seven chapters on what diapause actually is. Most of this contradicts the pinned guides. All of it is cited.

CHAPTER ONE

Diapause is not hibernation, and the difference kills colonies

Hibernation is a response. Diapause is a program. One you can interrupt; the other you cannot.

QUICK ANSWER

Ants do not hibernate. They enter diapause, which is a programmed developmental arrest, not a passive response to cold. A hibernating mammal is reacting to conditions and can be roused. An ant colony in diapause has entered a state that was scheduled in advance, is maintained by internal physiology, and in many species will not end just because you warm it up. The distinction is not pedantry. It determines whether your timing works.

Search "do ants hibernate" and you will get several million results, nearly all of which say yes, and nearly all of which are wrong in a way that matters.

The word hibernation describes a state that vertebrates enter and exit in response to environment and energy budget. A ground squirrel drops its body temperature, cycles through periodic arousals, and can be brought out of torpor by warming. The controlling variable is external. Take away the cold and, broadly, you take away the hibernation.

Diapause is a different animal. It is a developmental arrest that is centrally programmed and hormonally maintained. Denlinger's review of diapause regulation frames it as a distinct physiological state with its own initiation, maintenance, and termination phases, each under separate control.[3] It is not the absence of activity. It is the presence of a specific program.

The practical consequence is this. If diapause were hibernation, the recipe would be simple: make it cold, they stop; make it warm, they start. That recipe is what the hobby actually teaches. And for some species, in some years, it appears to work, which is why it survives.

Quiescence, the third thing

There is a middle category the hobby almost never names, and once you know it, several arguments dissolve.

Quiescence is what hibernation actually is, in insect terms: a direct, immediate slowdown caused by unfavorable conditions, which reverses the moment conditions improve. Cool an ant that is not in diapause and its metabolism drops because chemistry is temperature-dependent. Warm it back up and it resumes. Nothing was programmed. Nothing was scheduled.

Diapause is programmed arrest. It has a duration. It has to be completed. Warming a diapausing colony in December does not necessarily restart it, and in the species where it does not, the warming does damage without producing development.

Kipyatkov's terminology for ant seasonal cycles distinguishes exactly along these lines, and he mapped which ant genera fall where.[1] Some species show what he termed exogenous-homodynamic cycles: they only stop when conditions force them to, which is quiescence, and they resume immediately when conditions allow. Others show endogenous-heterodynamic cycles: they stop on an internal schedule that external conditions can nudge but cannot cancel.

THE THREE STATES, PLAINLY

Quiescence. Cold makes it slow. Warmth makes it fast. Fully reversible, no program, no schedule. This is what most keepers think diapause is.

Diapause. An internal program halts development. It has phases and a required duration. Warmth during the wrong phase does not restart it.

Post-diapause quiescence. The program has finished, but it is still too cold to develop. The colony is ready and waiting. Warmth here does restart it, immediately. This is the phase most keepers accidentally test in February and misread.

That third state explains one of the most common forum arguments. A keeper says they warmed their colony in January and it started laying, so diapause is clearly cold-driven and reversible. Another keeper says they tried the same thing and got nothing. Both are telling the truth. They caught their colonies in different phases. The first colony had completed diapause and was sitting in post-diapause quiescence, waiting on temperature. The second was still in diapause proper, and no amount of warmth was going to help.

Why the distinction kills colonies

Three specific ways.

One. It makes you late. If you believe cold causes diapause, you wait for the colony to slow down before cooling, because the slowdown is your cue that it is time. But in an endogenous species the slowdown is the diapause. It has started. You are now looking at a colony that has entered developmental arrest at room temperature, where its metabolic rate is high and its ability to feed is falling. Every day of that is fuel burned for nothing. Chapter 11 covers what that costs.

Two. It makes you interrupt. If you believe warmth reverses diapause, you will "check on" a colony by warming it, or you will cut diapause short because you are impatient, or your fridge will cycle. Interrupting diapause partway is worse than either completing it or skipping it, because you get the metabolic cost of both.

Three. It makes you skip. The most common version. A keeper in a warm apartment reasons that since their ants never experience cold, they never enter diapause, so they can keep the colony growing year-round. For a species with obligate endogenous diapause, that colony enters diapause anyway. It simply does so at 75 °F (24 °C), where the metabolic rate is roughly what it would be in summer, and burns through winter reserves in weeks instead of months.

> **THE MOST EXPENSIVE MISTAKE IN THE HOBBY**
>
> Skipping diapause does not mean the colony skips diapause. In obligate species it means the colony does diapause badly, at high temperature, with no fuel discipline. The colony that "grew all winter" is usually a colony that stalled all winter while you fed it and it did not eat.

What the hobby gets right

To be fair, because I have been unfair to the pinned guides and they deserve some credit.

Both forum guides get the practical outcome roughly right for the most commonly kept species. Cool your *Lasius* and *Camponotus* from roughly October to February at refrigerator temperatures and most of them survive and lay in spring. The recipe works often enough to persist.

It works because the recommended timing happens to coincide with the endogenous schedule of the species most people keep, which evolved in the same latitudes those keepers live in. The advice is right by accident of alignment, not by understanding of mechanism. Which is fine until you keep a species from a different latitude, or you live somewhere the schedule does not match, or you want to know why your colony failed. Then the recipe has nothing to say, because a recipe without a mechanism cannot be debugged.

That is what the rest of Part I is for.

CHAPTER TWO

The clock inside: endogenous diapause

The single most important finding in ant diapause research, and the hobby has never cited it once.

QUICK ANSWER

In many temperate ant species, diapause is obligate and endogenous. It is driven by an internal timer, and no combination of temperature and day length will prevent it. Kipyatkov's group demonstrated this repeatedly: colonies held under continuous long days at optimal temperature, including favorable fluctuating thermal regimes, still ceased development on schedule.[1,2,4] Cold does not cause the diapause. It permits the colony to survive it.

Vladilen Kipyatkov worked at St. Petersburg State University and spent roughly three decades on one question: what controls the seasonal cycle of an ant colony? The body of work that came out of that is, as far as I can determine, the most complete treatment of ant diapause that exists. It is also almost invisible to the hobby, partly because much of it was published in Russian-language journals and reached English readers through translation in *Entomological Review* and the *Journal of Evolutionary Biochemistry and Physiology*, which nobody in an ant forum is reading.

His central classification splits ant seasonal cycles along two axes.[1,2]

The first axis is **homodynamic versus heterodynamic**. A homodynamic cycle has no dormancy built in. The colony develops continuously and stops only if conditions force it. A heterodynamic cycle contains a genuine dormant phase as part of the annual program.

The second axis is **exogenous versus endogenous**. An exogenous cycle is controlled from outside: environment dictates when development stops and starts. An endogenous cycle is controlled from inside: the colony carries its own timer.

Cross those and you get the categories that matter. The one that should change how you keep ants is **endogenous-heterodynamic**: a built-in dormant phase, on an internal schedule, that the environment can shift a little but cannot cancel.

The experiment that settles it

The logic of the demonstration is clean. If diapause is caused by cold or short days, then giving a colony permanent summer should prevent diapause forever. So do that. Hold colonies under long-day photoperiod, at optimal temperature, well fed, indefinitely.

They stop anyway.

Kipyatkov's summary of this line of work is blunt. The diapause is driven by an internal timer, and no external condition can stop it. Give the colony long days. Give it the warm, fluctuating temperatures that are otherwise ideal for growth. Development still halts on schedule, and the dormant phase of the year begins anyway.[2]

Sit with that. Not usually. Not under most conditions. Development halts because that is what the program does.

And this is not a lone finding from one lab thirty years ago. A 2025 study on endogenous circannual cycles in temperate ants confirmed the same pattern independently, describing dormancy that begins after a fixed period even when the colony is held at warm temperatures on long days, and crediting the mechanism to the internal timer Kipyatkov called a "Sand-Glass Device."[27]

You are not putting your colony into diapause.
Your colony is going into diapause.
You are deciding how much it costs.

What this changes, concretely

Everything about your timing, and it is worth being specific.

Your cue is the calendar, not the colony. If the timer is internal and roughly annual, then the colony's behavior is a lagging indicator. By the time you observe reduced foraging and stalled brood, the program is already running. In an exogenous species you can watch and react. In an endogenous species watching and reacting means you are always late. You cool on schedule, and you build that schedule from the species' native latitude, not from what your colony looks like on a Tuesday in September.

Environment modulates, it does not decide. This is the nuance that keeps the hobby advice from being flatly useless. Kipyatkov and Lopatina's work on *Lepisiota semenovi* found exactly this pattern: an obligate diapause induced predominantly by factors internal to the colony, while photoperiod and temperature only nudged the timing, pulling the onset earlier or pushing it later without ever preventing it.[4] Short days and low temperature shortened the period before larval pupation and queen oviposition ceased. So the environment pulls the schedule forward or pushes it back. It does not delete it.

That is a knob, not a switch. Cooling early does not create diapause. It moves the onset a little earlier and, critically, it moves the colony into a temperature range where the arrest is cheap instead of expensive.

Skipping is not an option, it is a choice about cost. In an obligate species, the question is never whether the colony diapauses. It is whether it does so at 40 °F (4 °C) or at 75 °F (24 °C). Same arrest. Wildly different bill.

Not every species, and this is where honesty starts

I have to be careful here, and this is the point where most hobby writing stops being careful.

Kipyatkov's classification is a classification. It exists because ants do not all do the same thing. Some species genuinely have facultative diapause, where environmental cues do induce it and the colony can be kept developing. Some have no diapause at all. The endogenous-obligate pattern is well documented in specific studied species and is a reasonable default expectation for cold-temperate and boreal ants, which he addressed directly in his work on the evolution of seasonal cycles under those constraints.[5]

What I cannot tell you, and what nobody can tell you honestly, is which category your specific *Camponotus* or *Pheidole* or *Formica* species falls into, unless it happens to be one of the two dozen or so species that have actually been tested. Chapter 16 lists what has been. It is a short list.

THE HONEST POSITION

For a cold-temperate species you collected in a place with real winters, assume obligate endogenous diapause until you have evidence otherwise. That assumption costs you nothing if you are wrong, because a facultative species handled as if it were obligate simply diapauses on your schedule. The reverse assumption, treating an obligate species as facultative, is the one that empties nests.

This is a risk-asymmetry argument, not a scientific claim. I am telling you which way to be wrong.

Where the timer lives

A reasonable question: if there is an internal clock, whose clock is it? The queen's? Each larva's? The colony's?

The answer, and it is one of the strangest findings in the field, is that it is partly social. That is Chapter 4, and it is the second thing the hobby has never absorbed.

CHAPTER THREE

What cold actually does

If cold does not cause diapause, why does your colony need it? Three answers, all physiological.

> QUICK ANSWER
>
> **Cold does three jobs, and none of them is starting diapause.** It suppresses metabolic rate so the colony's fixed reserves last the whole arrest. It drives cryoprotectant synthesis, which is what actually keeps the ants alive at low temperature. And in many species it supplies the chilling requirement that diapause termination depends on. Skip the cold and you fail all three, in that order of visibility.

This is the chapter that makes the endogenous-timer argument actionable. Because if you have accepted that the colony was going into diapause anyway, the obvious follow-up is: then why bother with the fridge?

Three reasons.

Job one: the metabolic bill

An ant is an ectotherm. Its metabolic rate tracks ambient temperature. A colony in diapause has stopped bringing in meaningful food, has often sealed itself in, and is running entirely on what it stored in autumn. The reserves are fixed. The burn rate is not.

The general principle is old and well established. Storey and Storey's work on the metabolic side of overwintering describes diapause as a coordinated shutdown of the major energy expenditures associated with cell division, tissue differentiation, and growth, and notes that cessation of feeding itself saves the cost of digestion.[6] The program cuts what it can. But it cannot cut basal metabolism, and basal metabolism is temperature-driven.

The scale of what temperature does is worth seeing. In diapausing goldenrod gall fly larvae, midwinter metabolic rate measured just 35 to 40 percent of the early-autumn value at the same temperature.[6] That is the diapause program itself cutting the rate, before you account for temperature at all. Stack the temperature effect on top and the total reduction is what makes a four-month arrest survivable on autumn's fuel.

Run that same colony at room temperature and you have kept the diapause suppression but thrown away the temperature suppression. Fuel that was budgeted for four cold months goes in a fraction of the time.

KEEPER OBSERVATION, NOT LITERATURE

The signature of this failure in my own colonies was never a pile of dead ants in January. It was a colony that came out in March at maybe two thirds of its autumn worker count, with a queen that laid a visibly small first batch and then stopped. The colony was not killed. It was defunded. I recorded this pattern across three *Lasius* colonies over two winters when I was overwintering at apartment temperature. I have no controls and no measurements, and I am telling you this because it is the honest weight of the observation: it is a pattern, not a result.

Job two: cryoprotectants, which are the actual survival mechanism

This is the part the hobby guides skip entirely, and it is the most interesting thing happening inside your colony.

Insects surviving cold do not simply endure it. They chemically re-engineer themselves. The dominant strategy is accumulating low-molecular-weight solutes that depress the freezing point of body fluids and stabilize membranes and proteins through the cold. Glycerol is by far the most common of these, though sorbitol, mannitol, ribitol, erythritol, threitol, trehalose, sucrose, glucose, fructose, and various free amino acids all appear across taxa.[7] Salt's foundational work established the connection between natural glycerol occurrence in insects and their ability to survive freezing.[8]

Ants do this too, and there is a specific, well-documented case that any North American keeper should know.

The black carpenter ant

Cannon and Fell studied cold hardiness in overwintering *Camponotus pennsylvanicus*, the black carpenter ant, and it is one of the few pieces of proper cold-physiology work done on an ant species that Americans actually keep.[9] The summarized picture, as reported in Ellison and colleagues' field guide to New England ants, is that the colony seals its nest for winter, loses roughly half of its fat reserves over the season, and fills its body with glycerol as antifreeze, achieving freezing points as low as −8 °F (about −22 °C).[10]

Two numbers there deserve attention.

Half the fat reserves, gone. That is what a properly executed cold winter costs a carpenter ant colony. Half. Now consider what a warm winter costs, where the metabolic rate is three or four times higher and the arrest lasts just as long.

Minus twenty-two Celsius. Your refrigerator runs around 4 °C (39 °F). A wild *C. pennsylvanicus* colony is equipped for conditions roughly twenty-six degrees Celsius colder than that. The fridge is not a survival challenge for this species. It is mild.

But, and this matters, that glycerol did not appear by magic. It was synthesized, from stored reserves, in response to a seasonal signal. The cryoprotectant is a product. Its precursors are the fat and glycogen the colony banked in autumn, which is Chapter 11's entire subject.

Proline, and a result worth knowing

There is a related finding on *Camponotus japonicus* that shows how tight the coupling is between what an ant eats and what it can survive.

A group feeding L-proline-augmented diets to Japanese carpenter ants for five days found that whole-body proline concentration rose from 1.78 to 4.64 ng/g, and that when cooled to −27.66 °C, survival of frozen ants rose from 37.50 percent to 83.88 percent.[11] Roughly a doubling of survival, from a dietary change, over five days.

Proline is a known cryoprotectant. It stabilizes membranes during freezing, and that role, alongside trehalose, is long established.[7]

> **DO NOT OVER-READ THIS**
>
> That study is not a feeding protocol for your colony. It used a specific species, laboratory conditions, an augmented diet at controlled concentration, and a freezing challenge no fridge-kept colony will face. I am not telling you to feed your ants proline supplements. I am telling you that cold hardiness has dietary inputs, which is a reason to take pre-diapause feeding seriously, and which is a mechanism, not a recipe. Anyone who turns this into a supplement recommendation is going past the evidence.

What actually kills them, and it is not freezing

Here is the counterintuitive part, and it corrects a real misconception.

Keepers worry about their colony freezing. For most temperate species in a domestic fridge, freezing is not the threat, because the supercooling point sits well below anything the fridge will produce.

The threat is chill injury. Because the supercooling point of most overwintering insects is well below the lowest winter temperature they encounter, the biggest threat to survival is the cumulative impact of non-freezing chill injury, which is a function of both temperature and duration of exposure.[12] It accumulates. It is not an event you can point to.

Both variables are in your control. This is why "how cold" and "how long" are not independent questions, and why the forum habit of quoting a single temperature without a duration is close to meaningless.

Job three: the chilling requirement

The third job is the one that makes cold non-optional even if you could somehow solve the other two.

In many insects, diapause termination is not merely permitted by warmth. It requires a period of chilling first. The program will not complete without it. The general pattern in cold-hardy species is a defined diapause of fixed length followed by a period of cold quiescence, with warming only initiating development after the diapause itself has ended. In the goldenrod gall formers, an obligate diapause of about three to three and a half months ends around mid-February in the Ottawa region, and is followed by a period of cold quiescence until spring warming initiates pupation.[6]

Note the sequence. Diapause completes on its own schedule. Then quiescence. Then warmth triggers development. The warmth is the last step, not the first, and it does nothing if the earlier steps have not happened.

A colony that never got cold may sit in an incomplete diapause, unable to terminate properly, giving you a spring that never arrives. Keepers describe this as a colony that "never woke up." It did not fail to wake up. It never finished sleeping.

Putting the three together

WHAT COLD IS DOING, AND WHAT HAPPENS WITHOUT IT

JOB	MECHANISM	FAILURE SIGNATURE IF SKIPPED
Metabolic suppression	Ectotherm metabolic rate tracks ambient temperature; low temperature stretches a fixed reserve across a fixed arrest	Colony survives to spring but emerges thin, small first batch, worker count falls through summer. Looks like a bad year, not a failure.
Cryoprotectant synthesis	Cold cues glycerol and polyol accumulation from stored reserves[7,8,9,10]	Reduced cold tolerance. Mostly invisible in a fridge, where the challenge is mild. Matters if temperature control fails.
Chilling requirement	Diapause termination in many species requires a completed cold period before warmth can initiate development[6]	Colony does not resume in spring. No laying, no brood, sometimes for months. The "never woke up" colony.

Three jobs. One is invisible until March. One is invisible almost always. One is catastrophic and obvious. Which is precisely why the hobby underrates the first, ignores the second, and only argues about the third.

CHAPTER FOUR

The colony decides, not the ant

Diapause in ants is socially regulated. Workers control larvae. Queens control larvae. A pheromone perceived at a distance controls termination. This is not a metaphor.

QUICK ANSWER

An ant larva does not decide to enter diapause. The colony decides for it. Kipyatkov's group demonstrated that workers regulate larval diapause in three *Myrmica* species[13], that queens and workers together control both onset and termination of larval diapause in *Lasius niger*[14], and, most remarkably, that a primer pheromone perceived at a distance controls diapause termination in *Myrmica rubra*[15]. The unit of diapause is the colony. This is why colony fragments behave strangely, and why queen-only setups are not small colonies.

Everything in Chapters 1 through 3 could describe a solitary insect. A moth pupa has an endogenous timer, accumulates glycerol, and requires chilling. Nothing about that needs a society.

Ants are different, and the difference is the most underappreciated finding in this literature.

Workers control larvae

Kipyatkov and Lopatina examined social regulation of larval diapause across three species of *Myrmica*, and found that the workers are the controlling party.[13] Not the environment acting on the larva. The workers acting on the larva.

Think about what that requires. The workers must be reading some cue, integrating it, and then doing something to the larvae that changes the larvae's developmental trajectory. The larva is downstream. It is being told.

The same group looked at *Lasius niger* and found queens and workers both influencing the onset and the termination of larval diapause.[14] And in *Leptothorax acervorum* they described social regulation of development and diapause as well.[16] Three genera, same architecture.

The pheromone that works at a distance

Then there is the finding that made me stop and re-read the title.

Kipyatkov published work titled, and I am giving you the title because it is precise, "A distantly perceived primer pheromone controls diapause termination in the ant *Myrmica rubra*."[15]

Unpack that phrase by phrase. A **primer pheromone** is not a signal that triggers an immediate behavior. It is one that changes physiology and developmental state over time. **Distantly perceived** means it does not require contact. It works across space, through air. And it **controls diapause termination**: it is what ends the arrest.

So in *M. rubra*, the thing that ends diapause is not simply warmth. It is a chemical message moving through the colony.

Your colony is not a box of ants that each got cold.
It is a single system passing chemical messages
about what season it is.

What this means for how you keep them

Four practical consequences, and I want to be careful to separate what follows from the literature from what is my inference.

A queen alone is not a small colony. This is literature-grounded. If diapause onset and termination in larvae are regulated by queens and workers[13,14], then a founding queen with no workers is running a fundamentally different system from an established colony. She has no workers to regulate, and no workers regulating anything for her. Extrapolating established-colony diapause practice down to a founding queen is not obviously valid. The literature on founding queens is separate, and Kipyatkov's group addressed founding females specifically, which we come to in Chapter 6.

Colony size may matter, and I am guessing. If regulation is social and mediated by pheromone, then the concentration and reliability of that signal plausibly depends on how many ants are producing and receiving it. A colony of twelve workers and a colony of two thousand are not obviously running the same signal at the same fidelity. I have found no study testing colony size against diapause reliability. This is an inference from mechanism, flagged as such, and it is the kind of thing I would very much like someone to test.

Splitting a colony before diapause is a real intervention. Keepers split colonies casually. If diapause state is socially maintained, splitting is not just dividing a population. It is dividing a signalling system. Again: inference, not finding.

The "just do what nature does" advice is incomplete. Nature does not only supply a temperature curve. It supplies a temperature curve to an intact colony of natural size and structure. You are usually supplying it to a fragment.

WHERE I AM ON SOLID GROUND AND WHERE I AM NOT

Solid: workers regulate larval diapause in *Myrmica*[13]; queens and workers regulate onset and termination in *Lasius niger*[14]; social regulation exists in *Leptothorax acervorum*[16]; a distantly perceived primer pheromone controls termination in *M. rubra*[15].

My inference, untested: that colony size affects signal reliability; that splitting disrupts diapause regulation; that queen-only setups need different handling for this specific reason. These are mechanistically reasonable and empirically unsupported. Treat them as hypotheses I am handing you, not advice I am giving you.

Why nobody in the hobby knows this

Worth a paragraph, because it explains the shape of the problem.

This work is thirty years old. It is not obscure within myrmecology. It is invisible to the hobby because of a distribution failure: Russian-language publication, translation lag into journals that hobbyists do not read, no popular writeup, and a hobby culture where the pinned forum post is the canonical source and the pinned forum post was written by a keeper summarizing other keepers.

Information does not travel from journals to hobbies automatically. Somebody has to carry it. That is what this book is trying to be.

CHAPTER FIVE

The thermoperiod problem: why your fridge is not winter

A constant 4 °C and a fluctuating average of 4 °C are not the same input. The ants can tell. There is a study.

QUICK ANSWER

Fluctuating temperature and constant temperature produce different developmental outcomes even when the mean is identical. Kipyatkov's thermoperiod work found that a daily temperature swing, compared with a constant temperature at the same average, changed whether the colony kept developing or slipped toward diapause, and lengthened the seasonal cycle.[17] Your fridge holds a constant. Nature never does. That difference is a variable you are silently controlling.

Every diapause guide in the hobby gives you a number. Forty degrees Fahrenheit. Five degrees Celsius. Somewhere in there.

A single number describes a constant. Winter is not a constant. Winter is a distribution: a mean, a daily amplitude, a seasonal drift, and a texture of warm spells and cold snaps. When you put a colony in a refrigerator you are not giving it winter. You are giving it the mean of winter with the variance surgically removed.

The literature says the variance is not noise. It is signal.

The finding

The clearest demonstration comes from Kipyatkov and Lopatina's work on *Lepisiota semenovi*, where fluctuating and constant temperatures were compared at matched means.[17] The same effect appears across the thermoperiod literature on other genera, including *Myrmica* and *Formica*.[18]

The result: a colony held on a daily swing between 15 and 25 °C, or between 20 and 30 °C, behaved differently from one held steady at the same average. The swing pushed the ants toward continued growth and away from diapause, and it stretched the developmental season out.[17] Same mean temperature, opposite direction of travel.

Same average. Different outcome. The fluctuation itself was doing work.

And it gets more interesting. The direction of the effect was not fixed. Under short days in the St. Petersburg population, the effect of fluctuating temperature appeared to be the reverse of what it was under long days: thermoperiods caused earlier onset of diapause in both queens and larvae.[18] The authors noted openly that it remained uncertain whether this was specific to *M. rubra* or a general characteristic of St. Petersburg *Myrmica* populations.

So: fluctuation matters, its effect interacts with photoperiod, and it may vary by population. That is three levels of complexity beneath a hobby guide that says "40 degrees."

What this does not license

I want to head off the obvious over-reading, because I can see the forum thread it would produce.

This is not a finding that you should build a fluctuating-temperature diapause rig. The thermoperiod work above was done at 15/25 and 20/30 °C, which are growing-season temperatures, testing whether fluctuation modulates diapause *induction* under different photoperiods. It is not a study of diapause maintenance at winter temperatures. Nobody has shown that fluctuating your fridge between 2 and 7 °C beats holding it at 4.

What it licenses is a change in how confident you are. When a forum guide gives you a number with no amplitude, no duration, and no population, that number is carrying far less information than it appears to. It is one point estimate of a multi-dimensional input.

THE GENUINE HAZARD, WHICH IS THE OPPOSITE

Do not read this chapter as permission to let your temperature swing. Uncontrolled fluctuation in a domestic fridge is not a thermoperiod. It is a defrost cycle. Chill injury accumulates as a function of temperature and duration[12], and repeated warm excursions during diapause can add metabolic cost without producing development, which is the worst of both. The lesson here is epistemic humility about the number, not a license to stop controlling it.

The autumn ramp, which is the real application

There is one place where this matters practically, and it is not maintenance. It is the ramp.

In nature, autumn is not a step function. Temperature declines over weeks, with a daily amplitude, while day length shortens. The colony experiences a trajectory. In the hobby, the standard move is to take a colony from a shelf at 72 °F (22 °C) and put it in a fridge at 40 °F (4 °C). That is a thirty-two degree Fahrenheit step in the time it takes to close a door.

Given that cold acclimation is a process, that cryoprotectant synthesis takes time and substrate[7,8], and that rapid cold hardening exists precisely because sudden cold exposure is a distinct physiological challenge[12], a step function is a strange thing to hand an animal that evolved under a ramp.

Chapter 12 is the ramp protocol. The reasoning behind it is here.

The uncomfortable summary

You are controlling more variables than you know you are controlling.

When you put a colony in a fridge you are setting mean temperature, daily amplitude, which you have set to approximately zero, rate of onset, which you have set to nearly instantaneous, duration, photoperiod, which you have set to constant darkness, and humidity. The hobby guides discuss one of those six. Sometimes two.

The other four are still inputs. You are just not thinking about them.

CHAPTER SIX

Your queen has a latitude

Two colonies of the same species from different latitudes are not interchangeable. The response norm is local. This is the single most useful thing you can know about a wild-caught queen.

QUICK ANSWER

Diapause parameters vary by population within a species, tracking the latitude the population evolved at. Kipyatkov and colleagues demonstrated latitude-dependent variability in the response norm of *Lasius niger* founding females[19], and their *Myrmica* thermoperiod work compared St. Petersburg and Belgorod populations and found them behaving differently[18]. A species-level number in a care sheet is an average across populations that do not agree. Where your queen came from is data.

Here is a question the hobby cannot answer, and does not notice it cannot answer.

How long should *Lasius niger* diapause?

Every guide gives you a number. Three months. Four months. October to February. Now ask: *Lasius niger* from where? Because the species ranges across Europe from Mediterranean latitudes to Scandinavia. A colony from southern Italy and a colony from Sweden experience winters that are not remotely comparable. They have been experiencing those different winters, and being selected by them, for a very long time.

Are they running the same program?

They are not.

The response norm is local

Kipyatkov, Lopatina, Imamgaliev, and Shirokova studied the effect of temperature on rearing of the first brood by founding females of *Lasius niger*, and the finding is in the subtitle of the paper: latitude-dependent variability of the response norm.[19]

A response norm is how a genotype's phenotype changes across an environmental gradient. Saying it is latitude-dependent means that different populations of the same species respond to the same temperature differently, and the difference tracks where they are from.

Same species. Different program. Sorted by latitude.

The thermoperiod work reinforces it from another angle: populations of *M. ruginodis* and *M. rubra* from two regions were compared, near Vyritsa in the St. Petersburg region and near Borisovka in the Belgorod region, roughly a thousand kilometers apart.[18] They were compared because the researchers expected them to differ. And the reported uncertainty about whether an effect was specific to St. Petersburg *Myrmica* populations tells you the authors treated population identity as a live variable, not a footnote.

> *There is no such thing as*
> *"the diapause requirement of Lasius niger."*
> *There is only the requirement of*
> *the population your queen came from.*

What this does to care sheets

It does not destroy them. It bounds them.

A care sheet number is an average over populations that genuinely differ, usually derived from whichever population the writer happened to keep, generalized to the species. That is not useless. It is a prior. But it comes with error bars nobody prints, and the error bars are wider the wider the species' range.

The practical rule that falls out of this is the most useful thing in this chapter.

THE RULE

Diapause your colony on the schedule of the place the queen came from, not the place you live and not the species average.

If you caught her locally, your local climate is the schedule. This is the easy case, and it is an argument for keeping local species that nobody makes loudly enough.

If you bought her, find out where the seller collected her. Not the seller's address. The collection locality. If the seller cannot tell you, you have bought an animal with an unknown program, and you should say so out loud, because it is a real cost that the hobby prices at zero.

The commercial trade problem

Follow that logic and it lands somewhere uncomfortable.

A large fraction of colonies in the hobby are bought, not caught. They arrive with a species name and no locality. If the response norm is latitude-dependent, then locality is a required input to diapause planning, and the trade routinely does not supply it.

Which means a meaningful share of keepers are running a protocol calibrated to a population their colony is not from, and attributing the resulting failures to their own technique.

I am not accusing anyone of anything. Locality data is genuinely hard to maintain through a supply chain, and most sellers are one person with a shipping box. But the information is load-bearing, and the hobby treats it as trivia.

What to ask a seller

Three questions. They are not rude.

Where was the founding queen collected, at the level of state or region? What was the collection date? Is this a wild-caught queen or a colony bred in captivity, and if bred, from what parent stock?

A seller who can answer all three is selling you a substantially more valuable animal than one who cannot, and the hobby should price that difference. It currently does not.

Keeper's take

This chapter is the one that changed what I keep, not just how I keep it.

I stopped buying colonies with unknown provenance. Not on ethical grounds, though there are those. On practical grounds: I could not plan a diapause for an animal whose schedule I had no way to estimate, and I was tired of failures I could not diagnose. Local species with known collection sites gave me something the literature could actually be applied to.

That is one keeper's conclusion from one keeper's frustration, and you may weigh it differently. But if you are failing at diapause repeatedly with bought colonies, the variable you have not controlled may not be your fridge.

CHAPTER SEVEN

Photoperiod: the overrated cue

Day length is the classic insect seasonal signal. In ants it does less than you would expect, and in some species it may do almost nothing.

QUICK ANSWER

Photoperiod modulates ant diapause but rarely controls it, and for a subterranean colony this makes obvious sense. In *Lepisiota semenovi*, photoperiod and temperature produced a modifying effect on the timing on an internally controlled obligate diapause.[4] Work on *Lasius japonicus* concluded that although day length plays a critical role in the seasonal development of many temperate insects, it was less important than temperature in this species.[20] You do not need to build a light cycle for your fridge.

If you have read anything about insect seasonality you know photoperiod is the canonical cue. Day length is the most reliable environmental signal available: it does not care about a warm October, it repeats exactly every year, and it tells an organism where it is in the calendar with no noise.

For a butterfly, a beetle, an aphid, this is the master signal.

For an ant, it is complicated, and the reason is almost funny once you see it.

The ants are underground

A *Lasius niger* colony lives in soil. The queen may not see daylight from her nuptial flight until she dies. The brood never sees it. The workers that forage see it, but the workers that tend larvae, which is where diapause regulation is happening, are inside.

So how would a photoperiodic signal even reach the regulated party? It would have to be transduced: foragers perceive day length, and something about their behavior or chemistry carries that information inward. Which is possible, and given Chapter 4's pheromone findings, not even far-fetched. But it is a much longer causal chain than a caterpillar sitting on a leaf reading the sky directly.

A longer chain means more attenuation. And that is roughly what the literature shows.

What the studies say

In *Lepisiota semenovi*, Kipyatkov and Lopatina found a species with an endogenous-heterodynamic cycle and obligate diapause induced predominantly by factors internal to the colony, with photoperiod and temperature producing a modifying effect on the timing, accelerating or delaying diapause onset.[4] Photoperiodic regulation was demonstrably present. It was a modifier, not a controller.

The direction was as expected: under short days and low temperature, the periods of larval pupation and queen oviposition shortened markedly, meaning diapause came on earlier.[4] So the cue works. It just does not decide.

Work on *Lasius japonicus* put it more bluntly still, concluding that although day length plays a critical role in the seasonal development of many temperate insects, this variable was less important than temperature in this species.[20]

And Kipyatkov's *Myrmica rubra* behavioral work on photoperiodic regulation of larval development shows the effect is real and measurable in that species.[21] So it is not that photoperiod is inert in ants. It is that its weight varies by species and it is usually not the lead actor.

The interaction, which is the actual finding

The most interesting result here is not about photoperiod alone. It is that photoperiod and thermoperiod interact, and the interaction can flip sign.

Recall Chapter 5: under long days, thermoperiods stimulated non-diapause development and lengthened the seasonal cycle. Under short days in the St. Petersburg population, the effect reversed, and thermoperiods caused earlier onset of diapause in both queens and larvae.[17,18]

The same fluctuating temperature regime pushes diapause away under long days and pulls it closer under short days. The cues are not additive. They are read together.

Which means asking "does photoperiod matter?" is malformed. It matters conditionally on the thermal regime, and the thermal regime matters conditionally on the photoperiod, and both matter conditionally on the population (Chapter 6) and the species' position in the endogenous-exogenous spectrum (Chapter 2).

WHAT TO ACTUALLY DO

Do not build a light cycle for diapause. Your colony is in a dark box in a dark fridge, and this is fine. Subterranean species spend winter in the dark in nature. There is no published basis for engineering a photoperiod into a diapause rig, and no mechanism that suggests it would help.

Do not use lengthening days as your termination cue. Temperature is the stronger lever in the species where this has been compared[20], and termination in at least one species is under pheromonal control[15], not photic.

Do let natural light reach the colony during the growing season, if it does anyway. Ambient room light on a shelf is fine. This costs nothing and preserves whatever modifying effect exists.

Do not stress about it. Of all the variables in this book, this is the one with the best ratio of hobby anxiety to demonstrated importance.

Here is the part everyone else skips

There is a deeper reason photoperiod is weak in ants, and it explains the whole architecture of Part I.

Photoperiod is valuable to a solitary insect because it is a reliable external clock in a world where temperature lies. A warm week in October fools temperature; it does not fool day length. So evolution reaches for the sky.

But an ant colony has an alternative that a caterpillar does not have. It can carry its own clock, internally, socially maintained, and it does not need to look at anything. That is what an endogenous-heterodynamic cycle *is*: an internalized calendar. The colony is long-lived, it is buffered underground, it has thousands of individuals to average across, and it has chemical signalling to keep them synchronized.[15]

A solitary insect needs the sky because it has no other clock. A colony built its own.

Which reframes the whole thing. The reason photoperiod is a weak cue in ants is not that ants failed to evolve photoperiodism. It is that they did not need it as much. They solved the problem a different way, and the solution is the endogenous timer in Chapter 2 and the social regulation in Chapter 4.

Everything in Part I is one finding seen from different sides: the colony is a self-timing system, and your job is not to tell it what season it is. Your job is to make sure the season it has already decided on does not bankrupt it.

Part II is how to read what it decided.

PART TWO

Diagnosis

Before you touch the fridge: does this colony need diapause, has it already started, and is it fit to survive one?

CHAPTER EIGHT

Does your species actually need diapause?

Four questions, in order. Most keepers answer the last one first and get it wrong.

QUICK ANSWER

Work the decision in this order: native climate, then genus-level literature, then locality, then your own colony's behavior. The colony's behavior is the weakest evidence, not the strongest, because in an endogenous species behavior lags the program (Chapter 2). If the species evolved where winter happens, plan diapause. If it evolved in the tropics, do not. The hard cases are the in-between, and there are fewer of them than the forum arguments suggest.

This chapter is a decision procedure. It is deliberately mechanical, because the failure mode it prevents is keepers reasoning from the wrong evidence first.

Question one: where did this species evolve?

Not where you bought it. Not where you live. Where the species' natural range is.

This is the highest-weight evidence you have, and it is free. A species whose range includes real winters has been selected by real winters for its entire evolutionary history. A species from lowland tropics has not.

Kipyatkov addressed the evolution of seasonal cycles in cold-temperate and boreal ants directly, framing the patterns and the constraints those climates impose.[5] The short version: cold-temperate and boreal ants have seasonal cycles because they had no choice.

FIRST-PASS CLASSIFICATION BY NATIVE RANGE

NATIVE RANGE	EXPECT	DEFAULT ACTION
Boreal / cold temperate **(most of US and Canada, northern Europe)**	Obligate, likely endogenous	Plan a full diapause. Assume it is required. Chapter 2's risk asymmetry applies.
Warm temperate / Mediterranean	Variable; possibly facultative or short	Plan a shorter, milder diapause. Locality matters enormously here (Chapter 6).
Subtropical	Often none, sometimes a brief dry-season arrest	Probably no cold diapause. Do not refrigerate on principle.
Lowland tropical	None	Do not diapause. Refrigerating a tropical species is not conservative, it is harmful.

THE ERROR THAT RUNS ONE DIRECTION

Keepers who are unsure often refrigerate "to be safe." For a temperate species, that instinct is correct (Chapter 2). For a tropical species it is not safe at all: you are applying a cold challenge to an animal with no cold-hardiness program, no cryoprotectant response, and no chilling requirement to satisfy. There is no safe default. There is only a correct answer per species.

Question two: what does the literature say about the genus?

Species-level data mostly does not exist (Chapter 16). Genus-level data sometimes does, and it is a legitimate prior.

The genera with real published diapause work are, roughly: *Myrmica*[13,15,17,18,21], *Lasius*[14,19,20], *Leptothorax*[16], *Formica* and the subgenus *Serviformica*[18], *Camponotus* in part[9,10,11], *Lepisiota*[4], *Crematogaster* in part[22], and *Aphaenogaster*[1].

If your species is in one of those genera, you have a prior. If it is not, you have the native-range argument and not much else, and you should say so rather than pretend.

One genuinely useful comparative note from Kipyatkov's synthesis: among northern ants, *Formica* species have the shortest developmental times and develop almost twice as fast as *Myrmica* and *Leptothorax*.[2] That is a real, citable difference in the speed of the annual cycle between genera you may well keep side by side, and it means a single diapause schedule applied across your shelf is applying one number to animals running at different rates.

Question three: where did this specific queen come from?

Chapter 6 in one line: the response norm is latitude-dependent[19], populations differ[18], and locality is a required input that the trade usually does not supply.

If you know the locality, use it. Build your schedule from that place's climate. If you do not know it, use the species' range midpoint, flag the uncertainty in your log, and expect more variance in your outcome.

Question four, and last: what is the colony doing?

Deliberately last.

In an exogenous species, behavior is informative: the colony slows because conditions changed, and you can read conditions off the colony. In an endogenous species behavior is a lagging indicator of a program that is already running (Chapter 2). By the time the colony looks like it is entering diapause, it has entered diapause, possibly weeks ago, at whatever temperature you have been holding it at.

So behavior is not your trigger. Behavior is your confirmation that your calendar-based plan was roughly right, and your warning that it was late.

> **WHY KEEPERS GET THIS BACKWARDS**
>
> Because waiting for the colony to tell you feels responsible. It feels like observation, and observation is a virtue. But it is only observation if the signal leads the event. Here it trails it. Acting on it is not attentiveness, it is delay dressed as attentiveness.

The output

Four answers gives you a plan with a stated confidence.

Boreal range, genus with published work, known local collection site: high confidence, build the schedule from local climate, expect it to work.

Temperate range, genus with no published work, unknown locality: low confidence, use the range midpoint, log everything, expect to learn something.

Tropical range: no diapause, and the question is closed.

Write down which of those you are in. The single most valuable thing in your diapause log is not the temperature record. It is the sentence explaining what you assumed and why, so that in April you can tell whether the protocol failed or the assumption did.

CHAPTER NINE

Reading the signals your colony is sending

You cannot use these as triggers. You can use them as instruments. There is a difference, and it is the whole chapter.

QUICK ANSWER

Pre-diapause signals are real but late. Reduced foraging, brood development stalling, workers clustering, and the colony sealing entrances all indicate the program is underway. Use them to check your calendar, not to set it. If you are seeing them before your planned ramp date, your calendar is wrong for this population and you should move it earlier next year.

Chapter 8 said behavior is your weakest evidence for whether to diapause. This chapter says it is still worth reading carefully. Both are true, and the reconciliation is that a lagging indicator is useless as a trigger and excellent as an instrument.

Your thermometer does not decide the temperature. You still read it.

The signals, in rough order of appearance

Oviposition stops

The queen stops laying. This is often the earliest hard signal and it is the one the literature keys on repeatedly. Kipyatkov's work on *Lepisiota* measured exactly this: the period of queen oviposition shortening under short days and low temperature, meaning diapause onset came earlier.[4] Queen diapause is a defined state in this literature, not an incidental observation.

Practically: if you are tracking egg piles, and the pile stops growing and then starts shrinking as existing eggs develop through, the queen has stopped. Note the date. That date is your best single estimate of onset for this colony, this year.

Larval development stalls

Larvae stop growing and do not pupate. They sit. This is the classic larval diapause and it is what most of the *Myrmica* and *Lasius* social-regulation work is measuring.[13,14]

The tell is that it is not a slowdown, it is a stop. A cool colony's larvae grow slowly. A diapausing colony's larvae do not grow. If you have been photographing your brood, which you should be, the difference is obvious in a series and invisible day to day.

Foraging drops

Less traffic in the outworld, food left uncollected, protein ignored. Meaningful and easy to over-read, because foraging also drops when the colony is stressed, when the food is wrong, when the outworld is too dry, and when nothing at all is happening. It is a signal with poor specificity.

Clustering and sealing

Workers gather around the queen and brood and go still. In some species the colony seals nest entrances with soil or debris. *Camponotus pennsylvanicus* seals its nest for winter as a matter of course.[10] If your colony walls itself in, that is not a problem to fix. That is the animal doing its job.

Repletes fill and the colony gets fat

Late summer and autumn, workers take in more than they need and store it. Gaster distension, food caching. This is the colony banking the reserves that Chapter 3 says the whole winter runs on. *C. pennsylvanicus* loses roughly half its fat reserves over winter[10], which means it had to put that fat on first.

This is the one signal you want to see, and Chapter 11 is about causing it.

Every signal in this chapter arrives after the decision.
You are reading the receipt,
not placing the order.

The signals that are not signals

Four things keepers read as diapause onset that are not.

Workers dying. Workers die constantly. A colony at equilibrium loses workers every week. Autumn worker death is only meaningful against a baseline you almost certainly do not have.

Reduced activity after a disturbance. You moved the nest, you opened it, you took photographs with a bright light. The colony went quiet. That is a fright response and it will resolve in hours.

A single cold night. Your apartment dropped to 60 °F (16 °C) and the colony slowed. That is quiescence (Chapter 1), it is immediate, and it reverses when the room warms up. It is not diapause and it tells you nothing about diapause.

The calendar saying September. The month is not a signal from the colony. It is a signal from you.

Building the instrument

None of this works without a record, and this is where I have to be blunt about my own failures.

For my first three years I kept diapause "records" that consisted of remembering roughly when I put things in the fridge. When colonies failed I had nothing to diagnose with. I could not tell whether the colony had gone into diapause early, whether my ramp was too fast, or whether the queen had stopped laying in August and I had missed it. I had opinions. I had no data.

The log in Appendix A is what I use now. The essential columns are the ones that record state, not action: date the queen stopped laying, date larval growth stalled, date foraging dropped below baseline. Those three dates, collected across several years, will tell you more about your colony's actual schedule than any care sheet, because they are measurements of the population you actually have (Chapter 6).

Three years of that and you are no longer guessing. You are the only person in the world with data on your population.

CHAPTER TEN

The brood audit

What is in the nest when you cool it determines what survives. Eggs and pupae are the problem, and the standard advice about them is roughly right for once.

QUICK ANSWER

Cool a colony whose brood is at the stages that overwinter, not the stages that cannot. Hobby practice, which is consistent and plausible though I can find no direct experimental test, holds that eggs and pupae fare poorly through diapause while larvae and adults do fine. The mechanism is coherent: larval diapause is a defined state in the literature[13,14], meaning larvae are equipped to sit; pupae are mid-metamorphosis, which is not a state you can pause cheaply.

This is the one place where I am going to tell you the hobby is probably right, and then tell you why the evidence is thinner than the confidence.

The standard advice

Before diapause, let the pupae eclose and let the eggs hatch. Enter winter with larvae and adults only. If a species runs on a tight schedule and there are undeveloped pupae that will not make it, some keepers remove them.

You will find versions of this in every hobby guide. It is stated with total confidence.

Why it is probably right

The mechanistic argument is good, and it comes straight out of Part I.

Larvae are built for this. Larval diapause is the thing the ant literature spends most of its time on. Workers regulate it[13]. Queens and workers control its onset and termination[14]. It has a defined state that is entered and exited. An overwintering ant larva is not a larva that got stuck. It is a larva executing a program.

Adults are built for this. Cannon and Fell's carpenter ants are adults doing cold physiology properly: glycerol accumulation, fat mobilization, freezing points down at −22 °C.[9,10] Adults have the full toolkit.

Pupae are mid-transformation. A pupa is not resting. It is running the most metabolically committed process in the insect life cycle, rebuilding a larva into an adult. Diapause programs in other insects that use a pupal stage are specifically pupal-diapause programs, with their own physiology. The fall webworm overwinters as a diapausing pupa and does so with specific seasonal management of lipid, glycogen, and trehalose[23], which is to say: pupal overwintering is possible, but only where it evolved, and with dedicated machinery. Asking a non-diapause pupa to sit at 4 °C for four months is asking it to hold its breath.

Eggs are a race. An egg is a fixed yolk budget against a developmental clock. Cold slows the clock but the budget does not refill.

WHERE THE EVIDENCE ACTUALLY IS

I want to be honest about the citation status of this chapter. I have found no study that directly tests survival of ant eggs and pupae through an experimental diapause versus larvae and adults. What I have is: a large literature establishing larval diapause as a real, regulated state in ants[13,14,15,16]; work on adult ant cold physiology[9,10]; general insect literature on stage-specific overwintering physiology[6,23]; and universal, consistent hobby practice.

That is a strong convergent case and it is not a direct test. I am telling you it is probably right and that "probably" is doing real work in the sentence.

The audit, practically

Six to eight weeks before your ramp date, look in the nest and count what is there by stage. Then decide.

BROOD AUDIT DECISION TABLE

WHAT YOU SEE	WHAT IT MEANS	ACTION
Larvae and adults only	Ready	Proceed with the ramp on schedule.
Pupae present, colony still warm	Time to eclose exists	Hold at growing temperature until they eclose. Delay the ramp, do not compress it. Log the delay.
Eggs present, late in the season	May not hatch in time	Judgment call. If the queen stopped laying weeks ago these are the last batch and will likely hatch. If she is still laying, see below.
Queen still laying, ramp date passed	Your schedule is wrong or she is not diapausing	Stop. Re-run Chapter 8. Either your date is off for this population, or this is not a diapausing species.
Pupae present and no time left	The expensive case	See below. There is no clean answer.

The case with no clean answer

Your ramp date has arrived, based on a schedule you have reason to trust, and there are still pupae.

Three options, all bad.

Delay the ramp until they eclose. The colony spends more weeks in warm diapause, burning reserves at high metabolic rate (Chapter 3), to save some pupae. You are trading colony-level fuel for individual workers.

Cool anyway and accept the loss. You lose the pupae. The colony enters diapause on schedule with its reserves intact.

Remove them. Hobby practice in species with tight schedules. It is the same trade as option two, executed deliberately, and it prevents the colony spending resources tending brood that will not survive.

Which is right depends on how many pupae, how large the colony, and how confident you are in the date. I lean toward option two for established colonies, because a mature colony can afford the workers and cannot afford six warm weeks. For a small founding colony where those pupae are a third of the future workforce, the math inverts.

I am not going to pretend there is a rule. This is the point in every keeper's year where you find out whether you understand your colony or just your care sheet.

The founding queen exception

A founding queen with her first brood is a special case and deserves its own warning.

She has no workers. Chapter 4 says diapause regulation is social, mediated by queens and workers acting on larvae[13,14], and a solitary founding queen has none of that apparatus. Kipyatkov's group studied founding females of *Lasius niger* specifically[19], which tells you the founding stage was treated as its own problem, not a scaled-down colony.

She also has no reserves except her own body. Her flight muscles and fat body are the entire budget for the first brood, and diapause takes a bite out of the same account.

Standard hobby practice is that a queen who founded late in the season and has only eggs or young larvae goes into diapause with them, and this is what happens in nature. But the confidence should be lower here than the forums suggest, and the outcome variance is genuinely higher.

PART THREE

The Protocol

Eight weeks of preparation, four weeks of ramp, four months of boredom, and two weeks that decide the year.

CHAPTER ELEVEN

Pre-diapause: the eight weeks that matter most

Diapause is not survived on what you do in winter. It is survived on what the colony banked in autumn. This is the chapter the hobby does not have.

> QUICK ANSWER
>
> **The colony overwinters on a fixed reserve accumulated before the arrest. Building that reserve is the highest-leverage thing you do all year, and almost nobody does it deliberately.** *Camponotus pennsylvanicus* loses roughly half its fat reserves over winter[10], which means the autumn fat load sets the ceiling on winter survival. Feed hard, feed lipid-rich, and feed early, because a colony in diapause will not eat what you offer it in November.

Go back to the two pinned forum guides. Both tell you what temperature and how long. Neither has a section on what to do in the eight weeks before.

That omission is, in my view, the largest single gap in hobby diapause practice, and it follows directly from the causation error in Chapter 1. If you think cold causes diapause, then diapause begins when you apply cold, and everything before that is just normal keeping. If you understand that the colony is running a program on a fixed reserve, then autumn is not "before diapause." Autumn is diapause's funding round.

The account

Here is the model, and it is simple enough to hold in your head.

The colony has a fixed reserve: fat body, glycogen, stored food, and the crop contents of the workers. That reserve was accumulated in the growing season. During diapause the colony stops feeding meaningfully, which the literature treats as part of the program itself, since cessation of feeding saves the energetic cost of digestion and may cause gut regression[6]. So the account is closed. No deposits.

Withdrawals happen at a rate set by temperature (Chapter 3).

Survival is: reserve, divided by burn rate, must exceed duration.

You control all three. Duration is your schedule. Burn rate is your temperature. And reserve is the eight weeks nobody talks about.

Half the fat, gone by spring.[10]
That is what a good winter costs.
Now ask what a bad one costs.

What the fat is for

Two things, and the second is the one that will surprise you.

Fuel. Obvious. The colony burns it.

Cryoprotectant substrate. Less obvious, and it is the link Chapter 3 built. Glycerol and the other polyols are not free. They are synthesized from stored reserves, principally through glycogenolytic and gluconeogenic routes.[24] The carpenter ant that fills its body with glycerol[10] built that glycerol out of the account. So a colony that enters winter underfed is not merely short of fuel. It is short of the raw material for its own antifreeze.

That is a real coupling and it means underfeeding in September shows up as reduced cold tolerance in January, through a pathway no keeper would intuit.

The protocol

Weeks 8 to 5 before ramp: load

Feed as much protein and lipid as the colony will take. This is not the season for restraint. Insects, whole, as often as they will accept them. Sugar water or honey available continuously.

The goal is visible: distended gasters, workers that look heavy, food being cached rather than consumed immediately. If the colony is refusing protein, note the date, because that is your onset signal from Chapter 9 arriving early and your schedule needs to move.

Weeks 5 to 3: keep loading, watch the brood

Continue feeding. Run the brood audit from Chapter 10. This is when you find out whether your ramp date is going to work.

If there are pupae and time, hold warm and let them eclose. Newly eclosed workers going into diapause are fine. Pupae going into diapause are not.

Weeks 3 to 1: taper the protein, keep the sugar

Hobby practice, unverified: reduce protein in the last couple of weeks while keeping carbohydrate available. The reasoning offered is that uneaten protein in a nest at diapause temperatures is a mold vector, and that carbohydrate is the more useful thing to have in the crop going in.

I follow this. I cannot cite it. The mold argument is real and mundane and does not need a paper.

Week 1: hydration and cleanup

Water source topped up and reliable. Remove uneaten food, corpses, and anything organic that will rot. Check that the water reservoir will not run dry over four months, because you are not going to be opening this nest.

> **DEHYDRATION IS THE QUIET KILLER**
>
> Four months is a long time for a water source you set up once. A test tube whose cotton dries out in February will kill a colony that would have survived everything else you did. This is the least intellectually interesting failure in this book and one of the most common. Check the reservoir volume. Then check it again.

Keeper's take: what I got wrong for years

I fed my colonies well in summer and then, as autumn came and foraging dropped, I fed them less, because they were eating less. This felt like responsiveness. It was a feedback loop pointing the wrong way.

Foraging drops because the program has started (Chapter 9). Feeding less in response means the last weeks of available deposit time are spent depositing nothing. I was reading the colony's reduced appetite as reduced need, when it was reduced *capacity*. The need was identical. The window was closing.

What I do now is front-load. The heavy feeding happens in August and early September, before the appetite drops, on the calendar, not on the colony's cue. By the time the colony stops eating, the account is already funded.

That change did more for my overwintering survival than anything I did to my fridge. I have no controls and I am one keeper, so weigh it accordingly. But the mechanism in Chapter 3 predicts exactly this, and it is the only change I made where the reasoning and the result agreed.

CHAPTER TWELVE

The ramp down

Four weeks, not four seconds. Why the step function is the wrong shape, and what to do instead.

QUICK ANSWER

Bring the colony down in stages over roughly three to four weeks rather than moving it from room temperature to fridge in one move. The justification is mechanistic rather than experimental: cryoprotectant accumulation is a process requiring time and substrate[7,8,24], and rapid cold hardening exists as a distinct physiological response precisely because abrupt cold is a different challenge from gradual cold[12]. Nature ramps. Your fridge does not have to be a cliff.

The standard move is a step function. Colony sits at 72 °F (22 °C) on a shelf. Keeper opens fridge. Colony is now at 40 °F (4 °C). Elapsed time: about four seconds. Delta: 32 °F (18 °C).

Nothing in the evolutionary history of a temperate ant has prepared it for a rate of change like that.

Why the shape matters

Three arguments, in descending order of how confident I am.

Cryoprotectant synthesis takes time. This is well established. The accumulation of glycerol and other polyols is a biosynthetic process running through defined metabolic pathways, and the seasonal-expression work on those pathways shows them being regulated over weeks, not hours. In mountain pine beetle, a two-week lag was observed between the up-regulation of glycogen phosphorylase transcript in the fall and that of phosphoenolpyruvate carboxykinase, indicating that gluconeogenesis serves as a secondary glycerol-production route after the primary glycogenolytic source is exhausted.[24] Two weeks, just for the handoff between pathways.

Give a colony four seconds and you have given it none of that.

Rapid cold hardening is a separate emergency system. RCH allows almost instantaneous cold tolerance for brief exposures, minutes to hours, to non-lethal temperatures, particularly when the insect is not yet in a cold-hardy state.[12] The existence of a dedicated emergency response to sudden cold tells you that sudden cold is a recognized category of problem. RCH is what an insect does when it did not see it coming.

You do not want your colony running its emergency system as your protocol.

Chill injury is cumulative and rate-sensitive. The dominant threat is non-freezing chill injury, a function of temperature and duration.[12] An unacclimated colony dropped straight to 4 °C is accumulating chill injury from the first minute at a state of preparedness it would never have in nature at that temperature.

HONEST STATUS OF THIS CHAPTER

No study I have found compares stepped versus gradual cooling in ant colonies and measures overwintering survival. The ramp is mechanistically well motivated and experimentally untested in ants. It is also free, so the expected-value calculation is not close: a four-week ramp costs you nothing but patience.

The ramp

What follows is my protocol. The reasoning is cited. The specific numbers are mine and are calibrated to temperate species from continental climates. Adjust for your species and locality (Chapter 6).

FOUR-WEEK RAMP, TEMPERATE SPECIES

WEEK	TARGET	WHERE	NOTES
Week 1	64–68 °F (18–20 °C)	Coolest room, floor level, away from heat sources	Protein feeding stops here. Sugar available. Colony still active.
Week 2	55–60 °F (13–16 °C)	Unheated room, garage, basement, or a wine cooler	Activity visibly drops. Clustering may begin. Last hydration check with the nest open.
Week 3	46–50 °F (8–10 °C)	Fridge door shelf, or wine cooler at its warmest	The fridge door is the warmest part of a fridge. This is the one useful thing about it.
Week 4	39–43 °F (4–6 °C)	Fridge, main compartment, back and low	Final position. Do not move it again until termination.

Four weeks. Roughly eight to nine degrees Fahrenheit per week. Slow enough that the colony's biochemistry can track it, fast enough to fit in an autumn.

If you cannot do this

Most people do not have four temperature zones. Two honest compromises.

The two-stage ramp. Two weeks in the coolest available room, two weeks in the fridge. Not as good. Enormously better than the step function, and available to anyone with a hallway.

The wine cooler. A cheap thermoelectric wine cooler holds a settable temperature between roughly 45 and 65 °F (7 and 18 °C) and lets you run the whole ramp on a dial. This is the single best piece of equipment in this hobby for this purpose and Chapter 15 makes the case properly.

The autumn that does not cooperate

A real problem for keepers in warm climates or heated apartments: there is no cool room. Your options are 72 °F or 40 °F, and nothing between.

In that case the wine cooler stops being a nice-to-have and becomes the protocol. Without it you are choosing between a warm diapause, which Chapter 3 says is expensive, and a step function, which this chapter says is a shock. Both are real costs. The cooler removes the choice for about the price of a mid-range formicarium.

I recognize that "buy a thing" is an unsatisfying answer. It is also the true one, and I would rather say it than pretend a shelf next to a window is a thermal ramp.

CHAPTER THIRTEEN

Maintenance: the boring months

Four months where the correct action is almost always nothing. This is harder than it sounds.

> QUICK ANSWER
>
> **Hold temperature steady, keep water available, and do not open the nest.** The main risks in maintenance are dehydration, mold, temperature excursions from defrost cycles, and the keeper. Of those, the keeper is the one with agency. Every check you run has a cost: light, vibration, a warm excursion, and a disturbance to a colony whose whole strategy is stillness.

The maintenance chapter of most guides is one line: leave them alone. That line is correct and it is not enough, because it does not tell you what you are protecting against, and a keeper who does not know what the risks are will invent checks to feel useful.

Four risks. One of them is you.

Risk one: dehydration

The commonest maintenance failure and the least interesting.

Fridges are dry. They dehumidify by design, condensing moisture onto the cooling element and draining it away. Your colony is in a low-humidity box for four months with whatever water you gave it in October.

Mitigations, in order of how much I trust them: a large water reservoir sized for the whole period, not the month; a sealed or semi-sealed container that limits evaporation; the whole setup inside a lidded plastic bin, which buffers humidity and, usefully, buffers temperature swings too; and a damp sponge in that bin, replaced never, because you are not opening it.

The test is not whether the water source is adequate now. It is whether it will be adequate in February when you have not touched it for sixteen weeks.

Risk two: mold

Cold does not stop mold. It slows it, and some species do not care much. A nest with organic debris at high humidity and 4 °C for four months is a reasonable culture setup.

The prevention is entirely in Chapter 11: remove uneaten food, corpses, and organic matter before you close the nest. Once it is in the fridge your options are bad, because opening it to clean costs you a warm excursion and a disturbance, and the mold is already established.

Formiculture's own pinned health guide is tagged for mold, bacteria, and virus, which tells you the community knows this is a category. It has 18,838 views against 33,000 for each hibernation guide, which tells you the community underweights it relative to how often it is the actual cause of death.

Risk three: the defrost cycle

This one is genuinely underappreciated and it is a real argument against the appliance most keepers use.

A frost-free refrigerator does not hold a constant temperature. It runs a heater periodically to clear ice from the evaporator, and the compartment temperature rises during that cycle. Your 4 °C fridge is a 4 °C fridge on average, with excursions.

Chapter 5 established that fluctuation is not nothing to an ant[17,18], and Chapter 3 established that chill injury accumulates as a function of temperature and duration[12]. A defrost cycle is a warm excursion during diapause: metabolic cost without development, which is the worst combination available.

How much this matters, I do not know, and I want to be clear that I am not aware of anyone having measured it. But it is a systematic, repeated, uncontrolled input that most keepers do not know they are applying.

MITIGATIONS, RANKED

Best: a wine cooler. Thermoelectric units do not defrost-cycle the way a frost-free fridge does, and they hold a set point you chose rather than one optimized for milk.

Good: a thermal mass. Put the colony inside a sealed bin with a few liters of water or sand in bottles. Mass buffers excursions. This is cheap and effective and almost nobody does it.

Adequate: a manual-defrost fridge, or a fridge with a data-logging thermometer so you at least know what you are doing to them.

Blind: a frost-free kitchen fridge with no logger, which is what most of the hobby runs.

Risk four: you

The hardest one.

Every check costs something. Opening the fridge raises the temperature. Taking the nest out raises it a lot. Light on a colony that has been in darkness for eight weeks is a stimulus. Vibration is a stimulus, and there is a live thread on

Formiculture right now titled "How to fix vibration problem," which tells you keepers notice.

And what does the check buy you? You look at a still, clustered colony that looks exactly the way it looked last month, because that is what diapause looks like. You learn nothing. You paid for nothing.

The exception is if something has actually gone wrong, and the way to know that without opening the nest is instrumentation, not inspection.

If your only tool for checking on a colony is to disturb it, you will disturb it for no reason.

What to actually monitor, and how

Two instruments, neither of which requires touching the colony.

A min/max thermometer in the fridge, read through the door or wirelessly. This tells you your actual temperature range including the excursions you would otherwise never see. If you buy one thing after reading this chapter, buy this. It converts your fridge from an assumption into a measurement.

A visual check through the container, without opening anything. If your setup is transparent and lives in a clear bin, you can look at the water level and the general state of the colony by opening the fridge door for five seconds. That is a real check at a small cost.

Everything else waits until spring.

The schedule

MAINTENANCE, FOUR MONTHS

INTERVAL	ACTION	COST
Weekly	Read the min/max thermometer through the door. Reset it.	Five seconds of door-open. Negligible.
Monthly	Visual check of water level through the container.	Ten seconds of door-open and a light. Small.
If water is failing	Intervene. Add water with minimal disturbance, fast, and get it back in.	Real, and worth paying. Dehydration kills; a brief warm excursion usually does not.
Otherwise	Nothing.	Nothing.

That is the whole chapter. Four months of nothing, punctuated by reading a thermometer.

The reason it is hard is not technical. It is that you care about the colony and doing nothing does not feel like caring. But in diapause, restraint is the intervention. The colony is executing a program that has been refined over a very long time, and the single most useful contribution you can make between November and February is to stay out of its way.

CHAPTER FOURTEEN

Termination and the spring surge

Two weeks that decide whether the previous four months were an investment or a loss.

> QUICK ANSWER
>
> **Reverse the ramp, do not reverse the door.** Bring the colony up over two to three weeks, restore water and carbohydrate first, protein second, and expect the queen to resume laying within days to weeks. If nothing happens after several weeks at growing temperature, the likely cause is an incomplete chilling requirement (Chapter 3), and the colony may need another cold period rather than more warmth.

Termination is where the hobby's causation error does its last damage.

If you believe cold causes diapause and warmth ends it, then termination is trivial: take it out of the fridge. If you understand that diapause has a program with a defined termination phase, then warmth is the last step in a sequence, and it only works if the earlier steps completed.

What termination actually is

Recall the sequence from Chapter 3. Diapause runs its course on an internal schedule. Then the insect sits in post-diapause quiescence: the program is done, development is ready to resume, and it is waiting on temperature. Then warmth arrives and development initiates. In the goldenrod gall formers, the obligate diapause of roughly three to three and a half months ends around mid-February in the Ottawa region and is followed by cold quiescence until spring warming initiates pupation.[6]

Warmth is the last domino. It is not the hand that pushes the first one.

And in ants there is the additional layer from Chapter 4: in *Myrmica rubra*, termination is under the control of a distantly perceived primer pheromone.[15] Something chemical, moving through the colony, ends the arrest. Kipyatkov and Lopatina also found queens and workers controlling termination of larval diapause in *Lasius niger*.[14]

So the honest description of what you are doing when you take a colony out of the fridge is: you are permitting a socially regulated process to complete, if it is ready. You are not flipping a switch.

The ramp up

Reverse of Chapter 12, slightly faster, because warming is the direction the animal is built to want.

THREE-WEEK TERMINATION RAMP

WEEK	TARGET	ACTION
Week 1	46–50 °F (8–10 °C)	Move to fridge door or warmest cooler setting. Nothing else. No food, no opening.
Week 2	55–62 °F (13–17 °C)	Cool room. Check and restore water. Offer sugar. Do not offer protein yet.
Week 3	Growing temperature	Normal position. Sugar continuously. Introduce protein at the end of the week, small amounts, and watch whether it is taken.

Why water and sugar before protein

Hobby practice, and the reasoning is sound though I cannot cite it directly. The colony has been dehydrating slowly for four months and running on stored carbohydrate. Water is the immediate need. Carbohydrate is cheap to process and immediately usable. Protein is for brood, and there is no brood being reared yet, so protein offered on day one is protein sitting in a warm outworld growing mold.

Offer protein when the queen has started laying. That is the colony telling you it has a use for it.

The surge

What you should see, over roughly two to six weeks at growing temperature.

Foraging resumes first, usually within days. Then the queen begins laying, and in a healthy colony that came through well this is not a trickle but a burst, because the whole point of the arrest was to arrive at spring with the reserves to exploit it. Overwintered larvae, which sat all winter, resume development and pupate. Those are your first workers of the year and they eclose weeks before any egg laid in spring could possibly get there.

That last point is worth pausing on, because it is the payoff of the entire strategy. The overwintered larvae are pre-positioned. The colony did not spend winter waiting. It spent winter holding a workforce at the starting line.

The colony that diapaused correctly
does not start spring at zero.
It starts it with larvae already loaded.

When nothing happens

The failure mode that sends keepers to the forums in April: colony is warm, colony is fed, colony is doing nothing. No laying. No brood development. Weeks of it.

The instinct is to add heat. This is almost always wrong.

Work the causes in order.

Not enough time. Two weeks is not long enough to conclude anything. Give it four to six at proper growing temperature before you call it.

Diapause was not completed. The most likely real cause, and it comes straight out of Chapter 3's third job. If the cold period was too short or too warm, the chilling requirement may not have been satisfied, and the program has not terminated. More warmth does not fix this. What fixes it, if anything does, is another cold period, and you have to decide whether to spend one.

The colony is defunded. Chapter 11's failure. It survived, and it has nothing left to build with. This one is diagnosable: the colony looks thin, gasters are flat, and it does forage, hard, but the queen lays little. Feed it heavily and expect a poor year rather than a dead colony.

The queen is spent. Queens do not live forever, and a queen at the end of her life will come out of a diapause and not resume. This is indistinguishable from the above in the first few weeks and distinguishable in the first few months.

THE INTERVENTION THAT MAKES IT WORSE

Heating a colony that has not completed diapause raises its metabolic rate without enabling development. You are paying the summer rate for the winter product. If a colony has been warm for six weeks and is doing nothing, adding a heat cable is not a diagnostic step, it is an accelerant.

Keeper's take

The single change that improved my springs was not warming faster. It was writing down the date the queen resumed laying, every year, for every colony.

After three years I had a distribution instead of an anecdote. I knew that my *Lasius* resumed within about ten to eighteen days of hitting growing temperature, consistently. Which means that in year four, when one colony hit day thirty with nothing, I knew immediately that this was abnormal for that population rather than wondering whether I was being impatient.

That is what a record buys you: the ability to tell normal from wrong without guessing. It is the cheapest instrument in this book and it costs a notebook.

CHAPTER FIFTEEN

Equipment, measured

What to buy, in order of how much it changes your outcome per dollar. The list is shorter than you expect and the top item is not a fridge.

> QUICK ANSWER
>
> **Buy a thermometer before you buy anything else.** Every temperature claim in this book, and every temperature claim in every guide you have read, is worthless if you do not know your actual temperature. Most keepers do not. After that, a wine cooler if you can, a thermal mass if you cannot, and a notebook regardless.

Equipment chapters in hobby guides are usually shopping lists. This one is ranked by the thing that actually matters, which is how much each item changes the probability your colony survives, divided by what it costs.

Tier one: buy this first

A min/max digital thermometer, ideally with a remote probe

Twenty dollars. The highest-leverage purchase in the hobby.

Here is why it outranks everything. Chapter 3 established that chill injury is a function of temperature and duration[12], and Chapter 13 established that a frost-free fridge runs defrost cycles. So your colony's real thermal history is a range, not a number, and you do not know the range.

A min/max unit records the extremes between resets. One week of data will tell you things about your fridge you did not know: that the door shelf runs six degrees warmer than the back, that the compartment swings four degrees on a cycle, that the crisper drawer is the most stable spot in the box.

Until you have that, you are not running a protocol. You are running a hope.

A notebook

Free. Appendix A is the format. Chapter 9 and Chapter 14 both make the argument: without dates, you have no ability to distinguish a bad protocol from a bad year, and you will spend every spring re-litigating the same question with no evidence.

Tier two: buy this if you can

A thermoelectric wine cooler

Roughly one hundred to two hundred dollars for a small unit. This is the single best appliance for this purpose and it solves four problems at once.

It has a dial. A fridge has a set point chosen for food safety. A wine cooler has a set point chosen by you, typically adjustable across roughly 45 to 65 °F (7 to 18 °C), and some units go lower. That range is exactly the range Chapter 12's ramp needs, and it turns a four-zone problem into a dial you turn once a week.

It does not defrost-cycle. Thermoelectric units cool by Peltier effect and do not run the periodic heating cycle a frost-free compressor fridge does. Fewer uncontrolled excursions (Chapter 13).

It is not full of food. Nobody opens it six times a day. Every door-opening is a thermal event and a kitchen fridge gets dozens per day.

It is more humid. Less aggressive dehumidification than a frost-free fridge, which helps with Chapter 13's first risk.

The honest caveat: cheap thermoelectric units struggle to hold low temperatures when the room is warm, because their cooling delta is limited relative to ambient. If your house is 80 °F, a cheap unit may not reach 40 °F. Read the specification for cooling delta, not just the temperature range printed on the box.

Thermal mass

Effectively free. Two or three sealed bottles of water in the fridge or cooler with the colony.

Water has a high specific heat. Mass in the compartment buffers excursions: when the defrost heater runs, or the door opens, the mass absorbs the change and the colony experiences a smaller swing. This is real physics doing real work for the price of some bottles, and I have never seen it recommended in a hobby guide.

Tier three: nice, not necessary

A sealed bin. The colony inside a lidded plastic container inside the fridge. Buffers humidity, buffers temperature slightly, contains escapes, and stops the colony being disturbed by everything else in the fridge.

A data-logging thermometer. If the min/max unit revealed a problem you want to characterize, a logger gives you the shape of the cycle rather than just its extremes. Diagnostic, not operational.

A hygrometer. Useful if you suspect dehydration. Less useful than simply looking at the water level.

What not to buy

Anything that adds light on a cycle. Chapter 7. There is no basis for it. Your colony is subterranean and winter is dark.

A heat cable "for termination." Chapter 14's warning. A colony that has not completed diapause does not need more heat, it needs more cold, and heat at that moment is an accelerant on the wrong process.

A second fridge before you own a thermometer. This happens constantly. Keepers upgrade the appliance before they measure the one they have, and then have two unmeasured boxes instead of one.

> **THE WHOLE LIST, IN ORDER**
>
> Min/max thermometer. Notebook. Water bottles for thermal mass. A lidded bin. A wine cooler if the budget and the climate demand it. That is the equipment chapter, and the first three cost about twenty-five dollars combined and matter more than the last two.

Here is the part everyone else skips

The reason equipment advice in this hobby skews toward appliances and away from instruments is that appliances feel like solutions and instruments feel like admissions.

Buying a wine cooler feels like fixing the problem. Buying a thermometer feels like discovering you had a problem you did not know about, which is less satisfying and more useful. A keeper with a cheap fridge and a good thermometer knows what their colony experienced. A keeper with an expensive cooler and no thermometer has a nicer box and the same ignorance.

Measure first. Then decide what to buy, if anything. You may find your fridge was fine and your protocol was the problem, which is cheaper to fix and harder to admit.

PART FOUR

Species

What the literature covers, what it does not, and how to be honest about the difference.

CHAPTER SIXTEEN

What the literature actually covers

Roughly two dozen species, mostly Palearctic, mostly four genera. Everything else in your care sheet is extrapolation, and it should say so.

QUICK ANSWER

Ant diapause has been experimentally studied in a very small number of species, and almost none of them are the North American species Americans keep. The concentration is in *Myrmica*, *Lasius*, *Leptothorax*, and *Formica*, largely from European and Russian populations. For most species in the hobby there is no published diapause protocol, and every number you have been given for them is inference from a relative.

This is the chapter I was most tempted not to write, because it makes the book less useful in the way readers usually measure usefulness. You want a table. Species, temperature, duration, done.

I am not going to give you that table, because building it would require inventing most of it, and a fabricated number in a species table is worse than a blank cell. A blank cell tells you to be careful. A fabricated number tells you to be confident.

What is actually studied

Here is the honest map of the ant diapause literature as I have been able to assemble it.

GENUS	WHAT HAS BEEN ESTABLISHED	CAVEAT FOR A US KEEPER
Myrmica	The best-studied genus. Social regulation of larval diapause[13]; primer pheromone controlling termination in *M. rubra*[15]; thermoperiod effects[17]; population differences[18]; photoperiodic regulation of larval development[21]; winter versus summer brood pupae differing in thermal reaction norms[25]; polar-circle populations[18].	Nearly all European populations. *M. rubra* is introduced and invasive in parts of North America, so the work is directly relevant there, which is an odd silver lining.
Lasius	Queen and worker control of larval diapause onset and termination in *L. niger*[14]; latitude-dependent response norms in founding females[19]; temperature over photoperiod in *L. japonicus*[20].	*L. niger* is European. American *Lasius* such as *L. neoniger* are congeners, not the same animal. Genus-level inference only.
Leptothorax	Social regulation of development and diapause in *L. acervorum*[16]. Slower development than *Formica*[2].	Holarctic genus, so somewhat more transferable, but the specific work is European.
Formica	Regulation of the annual cycle in the	Large Holarctic genus with huge diversity. The

	subgenus *Serviformica*[18]. Notably fast developers: roughly twice the rate of *Myrmica* and *Leptothorax* among northern ants[2].	*Serviformica* work is a narrow slice.
Camponotus	Cold hardiness in *C. pennsylvanicus*[9,10]; proline and freeze tolerance in *C. japonicus*[11]; thermal effects on brood development in *C. herculeanus*[26].	This is cold physiology, not diapause regulation. We know how *C. pennsylvanicus* survives winter. We do not have its diapause control mechanism.
Lepisiota	Temperature and photoperiodic control of an obligate, endogenously induced diapause[4].	Turkmenistan. Nobody keeps this. It matters because it is one of the clearest demonstrations of the endogenous pattern.
Crematogaster	Regulation of larval diapause by colony-founding queens in *C. teranishii*[22].	Japanese. Relevant to founding-queen questions specifically.
Aphaenogaster	Seasonal development described in *A. sinensis*, reported as a new type of seasonal cycle[1].	South Primorye. Interesting for the classification, not for your shelf.

What that leaves out

Everything else.

There is no diapause study of *Pogonomyrmex*. None of *Veromessor*. None of *Pheidole* at the level of diapause control. None of *Solenopsis* in this respect. None of *Tetra-*

morium. None of *Prenolepis imparis*, which is the most interesting overwintering ant in North America and gets its own treatment in Chapter 18 precisely because its situation is so strange.

Those are among the most commonly kept genera in the United States. The literature is silent on their diapause regulation.

Roughly two dozen species, out of more than fourteen thousand.
Mostly European. Mostly four genera.
That is the whole evidence base.

What to do with a gap

Three legitimate moves, in descending order of confidence.

Genus-level inference. If your species is in a studied genus, the genus work is a real prior. American *Lasius neoniger* is not *Lasius niger*, but they are congeners with broadly similar biology and the inference is defensible if you flag it.

Climate-matched inference. If your species is not in a studied genus, use the native-range logic from Chapter 8 and Kipyatkov's framing of cold-temperate and boreal constraints[5]. A boreal ant faces boreal problems regardless of its genus. This is weaker and it is not nothing.

Your own data. The move nobody makes. If you keep a species with no literature, and you log properly for three years (Appendix A), you have generated the only diapause data that exists for that species in captivity. That is not a consolation prize. That is a genuine contribution, and the hobby's collective failure to do it systematically is why we are still arguing about pinned posts from 2016.

WHY CARE SHEETS DO NOT SAY THIS

Because "we do not know" is a bad sentence in a care sheet. It reads as incompetence. So writers fill the cell, usually by copying another care sheet, which copied a forum post, which was one keeper's guess in 2014.

Trace any hobby diapause number back far enough and you very often arrive at a person, not a paper. That is not a scandal. It is just the epistemic status of the number, and it should be labeled.

CHAPTER SEVENTEEN

The North American keeper's reference

The commonly kept genera, what we know, what we are guessing, and the confidence level for each. Every row is labeled.

QUICK ANSWER

This table gives you a starting point and an honest confidence rating, not a protocol. Where a number is from the literature it is cited. Where it is genus inference, it says so. Where it is hobby practice with no published basis, it says that too. Read the confidence column before you read the numbers.

Chapter 16 said I would not fabricate a species table. This is what an honest one looks like instead: fewer numbers, more labels, and a confidence column that is doing most of the work.

All temperature and duration figures below marked *practice* are common hobby practice, unverified against literature, and reflect what keepers in temperate North America broadly do. They are starting points to be adjusted by locality (Chapter 6) and logged (Appendix A).

COMMONLY KEPT NORTH AMERICAN GENERA

GENUS	DIAPAUSE?	STARTING POINT	BASIS AND CONFIDENCE
Camponotus **carpenter ants**	Yes, temperate species	Practice: ~4 months, fridge temperatures	**Medium.** Cold physiology of *C. pennsylvanicus* is genuinely established: nest sealing, ~50% fat loss over winter, glycerol accumulation, freezing point near −22 °C[9,10]. Diapause *control* is not established. Thermal effects on brood development studied in *C. herculeanus*[26]. Genus is large; tropical *Camponotus* do not diapause.
Lasius **including *L. neoniger***	Yes	Practice: ~3–4 months	**Medium.** Strong congeneric evidence from *L. niger*: social control of larval diapause onset and termination[14], latitude-dependent founding response norms[19]. American species not directly studied. Genus inference, defensible.
Formica	Yes	Practice: ~3–4 months	**Low to medium.** *Serviformica* annual-cycle work exists[18]. Genus develops roughly twice as fast as *Myrmica* and *Leptothorax* among northern ants[2], which suggests the whole cycle including diapause may run differently. Huge genus, thin coverage.
Myrmica **incl.**	Yes	Practice: ~4 months	**High, for *M. rubra*.** The best-studied ant in this literature[13,15,17,18,21,25].

introduced *M. rubra*			Termination under pheromonal control[15]. Populations differ[18]. If you keep *M. rubra* you have better information than anyone else in the hobby.
Tetramorium **pavement ants**	Yes, presumed	Practice: ~3–4 months	**Low.** No diapause literature found. Introduced, widespread, cold-temperate range. Native-range argument only (Chapter 8).
Pogonomyrmex **harvester ants**	Varies by species	Practice: shorter and milder, or none for southern species	**Low.** No diapause literature found. Range spans desert to temperate. Locality is doing all the work here and the hobby's numbers are guesses.
Veromessor	Varies	Practice: shorter, milder	**Very low.** No diapause literature found. Southwestern; winters are mild in much of the range. A care sheet exists on Formiculture for *V. pergandei*; it is keeper knowledge, not published work.
Pheidole	Varies enormously	Practice: short or none, species-dependent	**Very low.** No diapause control literature found. Genus spans tropics to temperate. Species identity and locality decide this and generic advice is close to meaningless.
Solenopsis	Generally no, southern species	Practice: none or brief cool period	**Low.** No diapause literature found. Mostly warm-climate in the US. *S. molesta* ranges further

			north and the answer likely differs.
Crematogaster	Yes, temperate species	Practice: ~3 months	**Low to medium.** Founding-queen regulation of larval diapause studied in Japanese *C. teranishii*[22]. Relevant to founding stage; limited transfer to American species.
Prenolepis imparis **winter ant**	**Inverted**	See Chapter 18	**Special case.** This species is active in cold and aestivates in summer. Applying standard diapause advice to it is actively wrong.
Leafcutters ***Atta, Acromyrmex***	No	None	**High confidence in the negative.** Neotropical and warm-temperate. Also running a fungus garden that will die if chilled. Do not refrigerate.

How to read that table

Notice that the confidence column and the specificity of the numbers move in opposite directions from what you would want. The species we know most about, *M. rubra*, is one many Americans consider a pest. The species most Americans keep, *Camponotus* and *Pogonomyrmex*, sit at medium and low.

That is the actual state of knowledge. Any table that looks more confident than this one is more confident than the evidence.

The rule for a low-confidence row

When your species is in a low-confidence row, the practice number is a hypothesis you are testing, not an instruction you are following. So test it properly: log it (Appendix A), record the outcome, and change one variable a year.

Three keepers doing that for three years on *Pogonomyrmex* would produce more usable knowledge than the last decade of forum argument. Nobody is doing it, because the hobby's reward structure pays for photographs, not records.

CHAPTER EIGHTEEN

The exceptions: winter-active and tropical species

Two categories where the entire book is wrong, and one of them lives in your backyard.

> QUICK ANSWER
>
> ***Prenolepis imparis* inverts the calendar: it is active in cold and dormant in summer heat. Tropical species have no diapause at all and refrigerating them is a cold challenge to an animal with no cold-hardiness program.** Applying the protocol in Part III to either is not conservative. It is the specific wrong thing.

Every rule in Part I and Part III assumes a temperate ant that stops for winter. Two categories break that assumption, and it is worth ending Part IV on them because they are the clearest demonstration that the mechanism matters more than the recipe.

The winter ant

Prenolepis imparis is called the winter ant for a reason, and it is one of the more remarkable animals in North American myrmecology. It forages at temperatures where other ants are shut down. It is out in late winter and early spring, on days that are cold by ant standards. Its nuptial flights are early, sometimes while there is still snow around.

And in summer, when everything else is at maximum activity, it goes quiet. The dormancy is inverted: this species undergoes a summer dormancy rather than a winter one.

Kipyatkov's classification of ant seasonal cycles[1] makes room for exactly this kind of thing, because his framework is about the structure of the annual cycle, not about winter specifically. A cycle with a dormant phase can put that phase wherever selection put it. In *P. imparis*, selection put it in July.

The Formiculture *Prenolepis imparis* thread runs to 240 replies and roughly 33,000 views, which is a lot of collective attention for one species. That attention exists because keepers try to apply standard advice to it and it does not work.

> **WHAT NOT TO DO TO A WINTER ANT**
>
> Do not run the Part III protocol on *P. imparis* as though it were a *Lasius*. You will be cooling an animal during the period it is built to be active and warming it during the period it is built to be dormant. That is not a mild error. That is the calendar inverted.

What to do instead is, honestly, less well established than I would like. The species' natural pattern is the guide: cool-season activity, summer quiet. Keepers who succeed with it broadly report following that shape. I have no diapause literature for this species to give you, and I am not going to construct a protocol out of nothing. Chapter 16's rule applies: this is a low-confidence species and your log is the instrument.

The tropical case

Simpler and more often gotten wrong out of caution.

A lowland tropical ant has no winter in its evolutionary history. It has no diapause program to run, no chilling requirement to satisfy, and no cryoprotectant response to deploy.

The entire apparatus described in Chapter 3 is absent, because there was never selection pressure to build it.

Put that animal in a fridge and you have not given it a rest. You have given it a cold injury with no defenses against it. Chill injury is a function of temperature and duration[12] in any insect; the difference is that a temperate ant has a program that anticipates it and a tropical ant does not.

Leafcutters compound this. *Atta* and *Acromyrmex* are not just tropical ants, they are tropical ants maintaining an obligate fungal symbiont. The fungus garden is a living crop with its own temperature requirements. Chill the colony and you may kill the garden, and a leafcutter colony without its garden is a colony without a food supply, regardless of whether the ants survived the cold.

The in-between, which is where people actually get hurt

The genuinely hard cases are neither tropical nor boreal. They are the warm-temperate and subtropical species where the answer is "some, briefly, maybe."

Southern *Pogonomyrmex*. Southern *Camponotus*. *Solenopsis* at the northern edge of its range. Species from Mediterranean climates. These are species whose native winters are real but mild, and whose diapause, if they have one, is likely shorter and warmer than the standard protocol.

For these, Chapter 6 is not a nuance. It is the whole answer. A *Pogonomyrmex* from Arizona and a *Pogonomyrmex* from Colorado are experiencing genuinely different winters, and the response norm is latitude-dependent[19], and the hobby gives you one number for the genus.

THE HONEST INSTRUCTION FOR AN IN-BETWEEN SPECIES

Find your queen's collection locality. Find that place's actual winter: mean temperature by month, and the length of the cold period. Build a diapause that approximates it, milder and shorter than the boreal default. Log everything. Expect to be adjusting it for three years.

That is more work than reading a care sheet and it is the only method that respects what Chapter 6 established. If that sounds unsatisfying, the alternative is applying a Scandinavian protocol to a Sonoran animal because a forum post rounded the genus to one number.

Here is the part everyone else skips

Why do these exceptions matter so much, given that most keepers keep ordinary temperate species where the standard advice roughly works?

Because the exceptions are the test of whether you understood the mechanism or memorized the recipe.

A keeper who memorized "cool them for four months" has no way to reason about *P. imparis*, because the recipe does not contain the concept of a dormancy that could be somewhere other than winter. A keeper who understood Chapter 2, that the colony runs an endogenous annual program with a dormant phase whose position is set by evolution, looks at the winter ant and thinks: the dormant phase is in summer, so the program runs on a shifted calendar, so I should be reading its native seasonality rather than my own.

Same keeper, same species, completely different reasoning available. That difference is what Part I was for.

PART FIVE

Failure

Symptom, cause, whether it was recoverable, and whether the forum consensus about it is correct.

CHAPTER NINETEEN

The autopsy index

Fourteen ways a diapause goes wrong, organized by what you actually observe rather than by what caused it.

> QUICK ANSWER
>
> **Most diapause failures do not present as death in winter. They present as a disappointing spring.** That is why they go undiagnosed: the keeper attributes a weak year to bad luck rather than to a protocol error four months earlier. This index is organized by symptom because symptom is what you have.

Every entry below gives the symptom as a keeper would describe it, the likely cause, whether it was recoverable at the point you noticed, and where the hobby consensus stands. Where I mark consensus as wrong, the reasoning is in the chapter cited.

Failures that appear in spring

> ### "It survived but came out much smaller than it went in."
>
> **LIKELY CAUSE**
>
> Warm diapause. The colony ran its arrest at high metabolic rate and burned reserves budgeted for four cold months in a fraction of the time (Chapter 3, job one). Or underfed autumn: the account was never funded (Chapter 11).
>
> **RECOVERABLE WHEN NOTICED?**
>
> The colony, usually yes. The year, no. Feed heavily and expect slow growth through summer.
>
> **CONSENSUS CHECK**
>
> The hobby mostly does not classify this as a diapause failure at all. It gets logged as a bad year. This is the single most under-diagnosed failure in the hobby.

> ### "It never woke up. Weeks at room temperature and nothing."
>
> **LIKELY CAUSE**
>
> Incomplete chilling requirement. Diapause did not terminate because the cold period was too short or too warm, so warmth has nothing to initiate (Chapter 3, job three; Chapter 14).
>
> **RECOVERABLE?**
>
> Sometimes, with another cold period. This is counterintuitive and it is the correct move.
>
> **CONSENSUS CHECK**
>
> **The hobby gets this backwards.** Standard advice is to add heat. Adding heat raises the metabolic bill without enabling development. This follows directly from the causation error in Chapter 1.

"Queen resumed laying but the eggs disappeared."

LIKELY CAUSE

A defunded colony recovering resources. Worker cannibalism of brood under nutritional stress is documented in ants: Kipyatkov and colleagues noted that the last eggs laid at the end of a seasonal cycle may be cannibalized by workers and larvae and disappear prematurely, as shown for *Formica*.[18]

RECOVERABLE?

Usually. Feed protein hard and the behavior typically stops.

CONSENSUS CHECK

The hobby reads this as a failing queen. Often it is a hungry colony, and the distinction is important because one is fixable.

"Small first batch, then she stopped."

LIKELY CAUSE

Reserve exhaustion. She had enough to start and not enough to continue (Chapter 11). Alternatively a spent queen at end of life.

RECOVERABLE?

Depends which. Feed heavily; if a second batch follows in four to six weeks it was resources. If nothing follows by midsummer it was the queen.

CONSENSUS CHECK

Consistent with hobby view. No disagreement here.

"Workers died off through spring faster than they were replaced."

LIKELY CAUSE

Accumulated chill injury, which is a function of temperature and duration and does not present as an event[12]. Too cold, too long, or too many excursions. Or simply an old worker cohort that overwintered at the end of its lifespan.

RECOVERABLE?

If the queen is laying, yes, slowly. The colony rebuilds.

CONSENSUS CHECK

The hobby rarely names chill injury and mostly discusses freezing, which is usually not the mechanism in a domestic fridge (Chapter 3).

Failures that appear in winter

"Everything was dry. Cotton hard, water gone."

LIKELY CAUSE

Dehydration. Fridges dehumidify. A reservoir adequate in October was not adequate in February (Chapter 13).

RECOVERABLE?

If caught early, yes. If found in March, no.

CONSENSUS CHECK

Correctly identified by the hobby and still the most common preventable death. Knowing about a risk is not the same as sizing a reservoir for it.

"Mold everywhere."

LIKELY CAUSE

Organic matter left in the nest at high humidity and low temperature for months. Cold slows mold; it does not stop it (Chapter 13).

RECOVERABLE?

Sometimes, by moving the colony, which costs a disturbance and a warm excursion. Weigh it. Established mold usually wins.

CONSENSUS CHECK

Well covered by Formiculture's health guide. The community knows. The community also views that guide about half as often as the hibernation guides, which is roughly the wrong ratio.

"Found them frozen."

LIKELY CAUSE

Actual freezing, which means a real equipment failure: fridge set too low, colony against the back wall or the cooling element, or a temperature control fault.

RECOVERABLE?

No.

CONSENSUS CHECK

The hobby's most-feared failure and one of the rarer ones. *C. pennsylvanicus* reaches freezing points around −8 °F (−22 °C)[10]; a 4 °C fridge is not close. If your ants froze, your equipment failed, and a thermometer would have told you (Chapter 15).

Failures that appear in autumn

"It stopped eating in September and I could not fatten it up."

LIKELY CAUSE

You were late. The endogenous program had already started and appetite had already dropped (Chapter 2, Chapter 9). The feeding window closed before you used it.

RECOVERABLE?

Not this year. Next year, front-load the feeding onto the calendar rather than the colony's cue (Chapter 11).

CONSENSUS CHECK

The hobby has no position on this because the hobby has no pre-diapause chapter. This is the gap that Chapter 11 exists to fill.

"There were still pupae when it was time to cool."

LIKELY CAUSE

Late brood, or a ramp date that does not match this population's schedule (Chapter 6).

RECOVERABLE?

It is a choice, not a failure. Chapter 10 lays out the three bad options honestly.

CONSENSUS CHECK

Consistent with hobby practice, which is right here.

"Queen was still laying well past my planned cooling date."

LIKELY CAUSE

Your date is wrong for this population, or this is not a diapausing species, or the ID is wrong.

RECOVERABLE?

Yes. Stop and re-run Chapter 8 rather than forcing the schedule.

CONSENSUS CHECK

The hobby tends to force the calendar. The calendar is a hypothesis about the population, and the colony just falsified it.

Failures caused by the keeper

"I checked on them a few times over the winter."

LIKELY CAUSE

Repeated warm excursions during diapause: metabolic cost without development (Chapter 13). Each check is small. They add.

RECOVERABLE?

Yes, by stopping.

CONSENSUS CHECK

The hobby says leave them alone, which is right, but does not explain the mechanism, so keepers do not know what they are buying with restraint and they defect.

"I cut diapause short because it looked ready."

LIKELY CAUSE

An interrupted diapause: you paid the cold cost without satisfying the chilling requirement (Chapter 3). You get the worst of both.

RECOVERABLE?

Possibly, by returning it to cold, if you catch it quickly.

CONSENSUS CHECK

The hobby understands that shortening is bad. It frames it as impatience rather than as an incomplete physiological program, which is why the advice does not stick.

"I moved it from the shelf straight into the fridge."

LIKELY CAUSE

The step function (Chapter 12). Cryoprotectant synthesis takes weeks[24]; you gave it seconds.

RECOVERABLE?

The colony often survives it. Whether it costs anything measurable is genuinely unknown, and I have flagged that the ramp is untested in ants.

CONSENSUS CHECK

Most hobby guides describe the step function as normal practice. I think it is wrong on mechanism and I cannot prove it on evidence. That is the honest position.

The pattern across all fourteen

Read the index end to end and one thing stands out.

The failures the hobby discusses most, freezing and mold, are the ones with the clearest symptoms. The failures with the largest aggregate cost, warm diapause and autumn underfeeding, produce no symptom at all until spring, and then produce a symptom the keeper does not attribute to diapause.

That is a systematic bias, and it is not anyone's fault. Communities learn from vivid events. A colony found frozen generates a thread. A colony that came out of winter at two thirds strength generates nothing, because nobody knows it was a failure.

Which is exactly why the log in Appendix A matters more than any single piece of advice in this book. It is the only way to see the failures that do not announce themselves.

CHAPTER TWENTY

The bottom line

What to actually do, in one page, and what to be honest about.

If you take one thing from this book, take this: your colony is not waiting for you to put it into diapause. It is already going. Your only decisions are how much the trip costs and whether it can complete.

The seven things that matter

One. Diapause is not hibernation. It is a programmed developmental arrest with phases and a required duration, not a passive response to cold you can switch off with warmth.[3]

Two. For many temperate ants the trigger is internal. Kipyatkov's endogenous-heterodynamic cycles proceed under long days at optimal temperature, including favorable thermal rhythms. Development necessarily ceases.[1,2,4] Cold does not cause it. Cold makes it survivable.

Three. Cold does three jobs. It suppresses the metabolic burn rate, it drives cryoprotectant synthesis[7,8,9,10], and it supplies the chilling requirement that termination depends on[6]. Skip it and you fail all three, but you only notice the third.

Four. The colony is the unit. Workers regulate larval diapause[13], queens and workers control onset and termination[14], and in *Myrmica rubra* a distantly perceived primer pheromone controls termination.[15] You are not managing ants. You are managing a signalling system.

Five. Your queen has a latitude. Response norms are latitude-dependent[19] and populations of the same species differ.

[18] There is no species number. There is only your population's number, and if you bought her without a locality you do not have it.

Six. Autumn funds winter. A carpenter ant colony loses roughly half its fat reserves over a good winter.[10] The reserve is fixed at the start and never refills. The eight weeks before the ramp are the highest-leverage weeks of your year, and no hobby guide has a chapter on them.

Seven. Measure something. A twenty dollar min/max thermometer and a notebook will teach you more about your colony than every care sheet ever written, because they are the only instruments that describe the population you actually have.

What I do not know

I want to end on this rather than on confidence, because the confidence is what got the hobby into this.

I do not know whether the four-week ramp in Chapter 12 does anything measurable in ants. It is mechanistically motivated and experimentally untested.

I do not know whether colony size affects diapause reliability, though Chapter 4's social regulation makes it plausible.

I do not know the diapause requirements of most species in Chapter 17's table, and neither does anyone else, and the table says so.

I do not know how much a defrost cycle costs a colony over four months. Nobody has measured it.

What I do know is that the field has thirty years of work by one Russian research group answering the exact questions the hobby argues about every October, and that in roughly a decade of pinned forum guides not one has cited it. That gap is not a failure of science. It is a failure of carrying.

*The literature was there the whole time.
Nobody carried it across.*

What to do next

Three things, in order.

Buy a thermometer and find out what your fridge actually does. You will be surprised, and being surprised is the point.

Start the log in Appendix A this autumn, even if you do nothing else differently. Three dates a year, for three years, and you will know your population.

Front-load your autumn feeding onto the calendar rather than waiting for the colony to tell you. It will not tell you until it is too late, because in an endogenous species the telling is the event.

That is the book. The mechanism is thirty years old, the protocol is four months long, and the part that matters most happens in August.

APPENDIX A

The diapause log

Three dates a year for three years and you will know more about your population than any care sheet does.

The argument for this is in Chapter 9 and Chapter 14. It is the only instrument that measures the population you actually have (Chapter 6), and it is the only way to see the failures that do not announce themselves (Chapter 19).

Copy this into a notebook or a spreadsheet. One block per colony per year.

Identity

FIELD	WHY IT IS HERE
Species, and confidence in the ID	An uncertain ID makes every other row uncertain.
Collection locality, state and region	The most valuable field in the log. Chapter 6.
Collection date	Establishes the population's native season.
Wild-caught or purchased	If purchased and locality unknown, write "unknown" and expect variance.
Approximate worker count at ramp	Chapter 4's open question. If enough keepers log it, someone can eventually answer it.
Confidence rating from Chapter 8	High, medium, or low. Write the sentence explaining your assumption.

The three dates that matter

OBSERVATION	NOTE
Date queen stopped laying	Best single estimate of diapause onset. Chapter 9.
Date larval growth stalled	A stop, not a slowdown. Photograph the brood weekly to see it.
Date foraging dropped below baseline	Requires a baseline. Weakest of the three, still worth having.

Protocol executed

FIELD	NOTE
Heavy feeding period, start and end	Chapter 11. Did the window close before you used it?
Brood audit result	What stages were present at ramp. Chapter 10.
Ramp start date and shape	Weekly targets actually achieved, not intended.
Final position and date reached	Where in the fridge, which matters more than keepers think.
Weekly min/max readings	The whole reason to own the thermometer. Chapter 15.
Any excursions and their cause	Power cut, door left open, a check you ran. Be honest.
Termination ramp start date	Chapter 14.
Date growing temperature reached	The clock for the next row starts here.

Outcome

FIELD	NOTE
Days from growing temperature to first eggs	The number that becomes your baseline. After three years you can tell normal from wrong.
Size of first batch, roughly	Small first batch is the defunding signature. Chapter 19.
Worker count at ramp versus at termination	The failure nobody notices. Chapter 19.
Did overwintered larvae pupate, and when	The payoff of a correct diapause. Chapter 14.
Anything unexpected	Write it down even if it seems irrelevant. Especially then.

THE ONE SENTENCE THAT MATTERS MOST

At the top of every year's block, write one sentence: "*I am assuming this colony needs X months at Y temperature because Z.*"

In April you will read that sentence and know instantly whether your protocol failed or your assumption did. Without it you cannot tell the difference, and you will spend the next autumn adjusting the wrong variable.

APPENDIX B

Pre-diapause checklist

The eight weeks, as a list. The reasoning is Chapter 11; this is the part you pin to the wall.

Eight weeks out

- Confirm the species decision from Chapter 8. Write the confidence sentence in the log.
- Set your ramp date from the queen's collection locality, not from a care sheet and not from your local weather.
- Begin heavy protein and lipid feeding. Front-load it. Do not wait for the colony to look hungry.
- Sugar or honey available continuously from here to the ramp.

Six weeks out

- Continue heavy feeding. Watch for distended gasters and food caching.
- If the colony is already refusing protein, note the date. Your ramp is late for this population. Move it earlier next year and consider moving it earlier this year.
- Buy the min/max thermometer if you do not own one. Put it in the fridge now, empty, and find out what the fridge actually does before you trust it with a colony.

Four weeks out

- Run the brood audit (Chapter 10). Count by stage.
- If pupae are present and there is time, hold at growing temperature and delay the ramp. Log the delay.

- Identify your ramp zones: which room, which shelf, which appliance, at what temperature. Measure them. Do not assume.
- Size the water reservoir for four months, not for one.

Two weeks out

- Taper protein. Keep carbohydrate available. (Hobby practice, mold argument, Chapter 11.)
- Remove uneaten food, corpses, and organic debris. This is your mold prevention and it is your only chance to do it.
- Confirm the fridge or cooler is holding your target with the thermal mass in place.

One week out

- Final hydration check. Reservoir full and sized for the duration.
- Final cleanup. Nothing organic left in the nest or outworld.
- Colony into its bin, with thermal mass, ready to move.
- Log block opened for the year with the assumption sentence written.

Ramp week one

- Begin the four-week ramp (Chapter 12). Do not skip to the end.
- Record the actual temperature achieved each week, not the intended one.

THE TWO FAILURES THIS LIST PREVENTS

Almost everything on this page exists to prevent two specific failures: an underfunded colony (Chapter 11) and a dry nest in February (Chapter 13). Those two account for more dead colonies than every exotic mechanism in this book combined, and both are prevented in autumn by a person with a checklist.

APPENDIX C

What we still do not know

The open questions, stated plainly, so that a keeper with a notebook can take one.

This appendix exists because Chapter 16's gap is not a permanent condition. It is a research agenda that nobody has picked up, and much of it is answerable by keepers with logs rather than by laboratories with grants.

Questions the literature has not answered

Does colony size affect diapause reliability? Chapter 4 establishes that diapause regulation is social[13,14,15]. If the signal is pheromonal and distributed, colony size plausibly affects its fidelity. Nobody has tested it. A keeper with several colonies of one species at different sizes could produce the first data on this.

Does a gradual ramp beat a step function in ants? Chapter 12's protocol is mechanistically motivated[7,8,12,24] and experimentally untested in ants. This is testable by keepers: two colonies, same species, same locality, one stepped, one ramped, worker count and first-batch size recorded. Repeated across enough keepers it would settle.

What does a defrost cycle cost? Chapter 13 flags it. Nobody has measured it. A keeper with a data logger and two colonies, one in a frost-free fridge and one in a thermoelectric cooler, would produce a genuinely novel result.

What are the diapause requirements of *Pogonomyrmex*? Or *Veromessor*, or *Tetramorium*, or American *Lasius*, or *Pheidole*. Chapter 17's low-confidence rows are open questions, and every one of them is answerable by three keepers logging for three years.

How does *Prenolepis imparis* actually run its inverted cycle? Chapter 18. The species is well known to keepers and unstudied on this axis.

Does the trade's loss of locality data measurably degrade outcomes? Chapter 6 predicts it should. Nobody has looked.

Why keepers can answer these

Because the hard part of this research is not equipment. It is the four months of patience and the notebook, and keepers already have both.

A laboratory studying ant diapause needs colonies, a controlled environment, and years. Keepers have thousands of colonies, in every conceivable condition, across every latitude in the country, running four-month experiments every single winter, and throwing away the data.

That is the actual scandal here. Not that the science is hard. That the experiment is already running at enormous scale and nobody is writing it down.

IF YOU WANT TO TAKE ONE

Pick one question. Pick one species. Log it for three years using Appendix A. Change one variable per year and no more.

Post the results whether or not they are interesting, because a null result posted is worth more than a positive result inferred. And cite what you did precisely enough that someone else can repeat it, which is the one thing forum posts almost never do.

That is how a hobby stops arguing about pinned posts from 2016.

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Every numbered citation in this book. Where I could not verify a volume or page number, the entry says so rather than guessing.

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A note on reference precision. Several entries above are marked as not independently verified. This is deliberate. Much of Kipyatkov's output was published in Russian-language journals and reached English readers through translation, and several items are cited here from reference lists and secondary summaries rather than from the papers themselves. Rather than fabricate a volume number to make a bibliography look tidy, I have marked what I could not confirm. If you are building on this work, go to the primary sources.

Last reviewed: July 2026. Sourcing method: literature search, primary-source verification where accessible, and explicit labeling of unverified entries. Corrections are welcome at antaddict.com.

About the author

Sabri Hayouni has kept ants for six years and has been getting diapause wrong for four of them, which is the only qualification that matters for a book like this. He writes at antaddict.com, where the ant-keeping content is researched against primary literature rather than against other people's care sheets. He is not a myrmecologist.

Everything in this book that is worth anything came from people who are, and is cited to them.