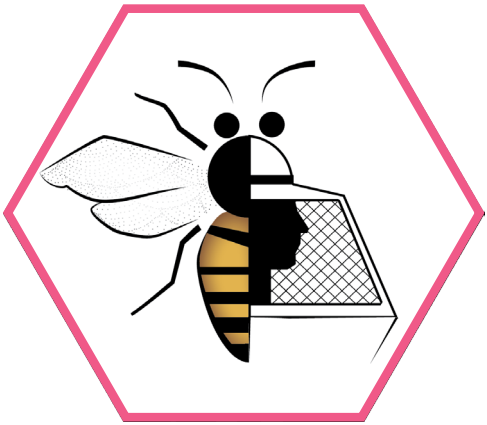
With the Bees

With the Bees:

BUILDING A PARTNERSHIP BETWEEN BEES AND THEIR KEEPERS

by
Marcel Durieux and
Anita Impagliazzo



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Introduction

Courtesy of Patti Bowen Hollinger

Yet another beekeeping manual?

We already can hear people asking. Is the world really in need of yet another manual teaching us how to keep bees? Have others not described that topic very well and exhaustively, many times over? What does this book offer that the others don't? And why would I want to take up this bee-keeper partnership—whatever it is?

These are valid questions, and therefore we will start by giving you some good reasons why the world does have a definite need for this manual.

Yes, beekeeping has been very well and exhaustively described before. But typically, it has not been covered appropriately for much of the modern audience. **Most beekeeping texts describe the craft as it is done when your purpose is to maximize the amount of honey harvested.** That, of course, is what commercial beekeepers are after, and it is a valid approach if you need to make a living from your business. It takes effort and money, though, and, as with managing other livestock, it is hardly to the benefit of the bees. Remember how chickens for egg production are treated? Commercial beekeeping requires frequent and active interference in the life of a colony in order to maximize honey yields: stop them from swarming, treat them with chemicals against pests, replace queens frequently so that you always have an optimal egg producer, inspect early and often to catch anything that could imperil the honey yield.

Since this is the standard way to keep bees in much of the world, most beekeeping books written for backyard beekeepers take this commercial approach as a starting point and just scale it down for the hobbyist. But—although they may not all realize it yet—this approach is not what most hobby beekeepers want these days. Yes, you want honey, but (if you are like us) you primarily keep bees for your own enjoyment, to help the environment, to connect with nature. Believe us, there is a limit to how much honey you need, even if you give it away or sell some. Techniques that aim at maximizing honey production simply are not what you are after as a hobby beekeeper. **What you need to know is not how to produce honey, but how to keep bees.** And that's what this book is about.

Once you look beyond honey yields, it turns out you can stay away from those intensive beekeeping practices. You can create a partnership between your bees and yourself: a bee-keeper partnership, with great benefits for both the bees and for the beekeeper:

- **For the bees: you can start putting their needs first.** Commercial beekeeping practices are far from bee-friendly and, as we will see later, contribute to many of the survival difficulties that bees struggle with these

days. From trucking millions of bee colonies around the world each year for pollination to forcing them to forage on a single type of flower, commercial beekeeping imposes its will on the bees in ways that can hurt them. The bee-keeper partnership as described in this book takes a different approach. It means working with the bees, instead of thwarting the impulses and instincts they evolved over millions of years. It means letting the bees do their own thing as much as possible. Do not interfere with the swarming process (but catch the swarms). Do not replace queens (but let the bees themselves select their next queen). Minimize inspections to those absolutely necessary and even then, limit the disturbance of the hive. Stay away from most chemical treatments.

- **For you:** the bee-friendly approach requires much less investment in time and money. As much as hobbyists might want to, they can't spend all their time with their bees, so they want their beekeeping to be sim-

How much honey do you need?

Let's do a quick calculation to estimate how much honey you need per year to supply a beekeeping family of four. The average honey consumption per person in the US is about 1.5 pounds (0.7 kg) per year. Of course, lots of people don't eat honey at all, unfortunately. If you just look at the people who do, their annual use is about 2.5 pounds (1 kg). Of course, everyone in our hypothetical beekeeping family will eat honey, and let's assume they eat a lot more than average. In fact, let's have them eat double the average. That means 5 pounds (2 kg) per person per year, or 20 pounds (9 kg) per year for the family. Now let's also assume that—beekeepers being nice people—they like to give away honey. Maybe they give away about the same amount, 20 jars per year. That brings us to 40 pounds (18 kg) total. And let's generously round this up to 50 pounds (23 kg). There you have it: if you are a typical beekeeper and your bees bring in 50 pounds of honey per year, your needs are covered (of course, there are no typical beekeepers, so your mileage may vary).

How many hives do you need to bring in 50 pounds of honey per year?

This depends a bit on where you live, as honey yields differ greatly by location. It ranges from 30 to 80 pounds (14 to 36 kg) per hive per year across the US (you can look up the annual national reports here: https://usda.library.cornell.edu/concern/publications/hd76s004z). The average? 55 pounds (22 kg) per year. Now, those 55 pounds come from commercial hives managed for honey production. Ours explicitly are not. So let's assume our colonies yield only half of that amount, about 25 pounds (11 kg). That means that with two hives, or three if you live in a low-yield area, your honey needs will be comfortably covered. What all this tells us is that hobby beekeepers have absolutely no need for approaches that maximize honey production.

ple, with limited interventions. This is therefore how we approach the craft in this manual. And, of course, as a hobby, it can't become too expensive. The most expensive part of beekeeping these days is the bees. Yes, hives and equipment are not cheap, but they last a very long time. Bees, in contrast, die. Regularly, and in great amounts. Over the past years, close to half of all bee colonies in the US died annually. For you, that means having to look forward to replacing hundreds of dollars of bees every year. Investments in woodenware pale next to that. The beekeeping methods described here largely do away with the need to buy bees. Plus, we use smaller hives, we eliminate the need to buy expensive pharmaceuticals, we don't replace queens (a mated queen costs about $50 in the US and £40 in the UK these days), and we limit what we require in the ways of tools, hive parts and other equipment.

This is what the bee-keeper partnership is all about: focusing more on the bees and less on the honey, and doing it in a natural, simple, and inexpensive way. With benefits both for you and for your bees.

I'm an experienced beekeeper. Is this right for me?

Yes, it is. Making the transition from traditional beekeeping to a bee-keeper partnership is quite simple. The main new things to learn have to do with attracting swarms: how to construct swarm boxes and how to manage a newly caught swarm. In many ways the process of attracting swarms is much easier for the established beekeeper than for the hobbyist just starting out on the journey. First, you already have one or more hives on your property that will be a source of swarms, so your likelihood of attracting a swarm is much higher. Second, you will likely have drawn-out frames from previous years, which will make it much easier for a new swarm to establish itself as a new colony. Most importantly, you already have experience in handling bees. You only have to learn a few new approaches, not a whole new craft.

Most likely you will be used to techniques and schedules different from those we advise in this manual. That is okay. You are very welcome for now to keep doing what you are used to doing as far as hive management is concerned. The transition to a more bee-friendly approach can be very gradual. Over time, you can try out some of the procedures and approaches we suggest. Maybe fewer inspections, maybe not marking or looking for the queen. It may feel a bit strange at first, but you will soon note the benefits of this approach to beekeeping. No more buying bees or queens and installing packages or nucs. A way of handling and managing your bees that is just a little less invasive and more natural. And an opportunity to learn about and

experience first-hand how bees like to arrange their own lives, including that most magnificent event of a bee colony reproducing itself.

Our advice then for an experienced beekeeper reading this manual: skim through *Part 1*, start applying *Part 2*, and over time work through *Part 3* and *Part 4*.

I'm a "newbee". Is this right for me?

Yes, it is, but you do have a few things to consider.

- The most important consideration has to do with how you get your very first bees. Our method depends on catching swarms to supply our bees. If you are just starting out, you have no guarantees that you will catch a swarm. This is particularly true if you have no other hives close by where swarms can come from. Thus, you run the risk of simply not getting any bees and having to wait a year, or more. To avoid this sad possibility we would recommend that, unless cost is an insurmountable barrier, you start your first year as a beekeeper with bought bees. You can still apply all the management techniques described here, but don't depend on swarm catching to get started with beekeeping. Once you have one or two hives going, you can then begin the transition to attracting swarms.
- Our writing style in most of the book targets an audience that has at least some experience with keeping bees, let's say one or two years. We don't require much in the way of prior knowledge, but we do expect some experience with the basics. **However, to help you—the novice beekeeper—out, the first section in the book summarizes relevant beekeeping basics in the context of a bee-keeper partnership** and, very importantly, gives you a realistic picture of the costs of beekeeping—both traditional and our approach. Some other information you will have to look up for yourself on the web (see ***What is NOT in this book*****,** below). If you decide to follow our suggestion to start with bought bees you will need more detail on traditional beekeeping practices, and you will find plenty of excellent books available to teach you that. We reference some in the *Reading List*. It also is a great idea to take a beekeeping class, and to join a beekeeping club, so that you will hear some different points of view and have a place to go with your questions.
- **Finally, as a novice beekeeper, learning the techniques described in this book will be a bit more challenging,** as you will not find as many people able to help you as would be the case for more 'standard' beekeeping. Granted, any advice from beekeepers can at times be more confusing than helpful (the saying is that if you ask three beekeepers about something, you get four opinions!), but still, it will be much

easier to connect to a mentor who can help you set up with bought bees than to find people who can help with catching swarms. On the other hand, with our approach of limited inspections and interventions, there is not quite as much to learn in the way of techniques. Our advice for a beginner reading this manual: Study ***Part 1***, skim through ***Part 2*** for now, and then start applying ***Part 3*** and ***Part 4***.

I'm an urban beekeeper. Is this right for me?

Yes, it is. The bee-keeper partnership is a great approach for any hobbyist, but it may be of particular interest to a whole new group of apiarists that has sprung up over the past decade: the urban beekeepers. These are the people who live in the city or suburban environment, who have limited space around them, and who want to maintain one or two hives in that setting.

There are several reasons why these approaches are particularly suited to the urban beekeeper.

- **Urban bees produce more honey.** Yes, you read that correctly. A colony maintained in the urban environment makes more honey than one out in the country, about 10 pounds (5 kg) more in their first year. What does this mean for the urban beekeeper? It means you'll get plenty of yield from a few hives, and your techniques and approach need not be focused on squeezing out as much honey as possible. What makes urban bees such good honey producers? The city and the suburbs typically have lots of people planting shrubs and flowers, in a much greater variety than is available in other settings. Those people take care to plant flowers that will bloom at various seasons. And they fertilize and water the plants. As a result, forage is available to bees throughout much of the year. Importantly, urban bees can find a variety of types of pollen (which is the protein, fat, and vitamin/mineral part of the bees' diet). They therefore enjoy more diverse nutrition, and this has been shown to result in a longer life span. In contrast, outside the "built environment" bees may find very few flowers (as is the case in some forested areas) or they may have to do with one or a few brief flowering periods of a single crop (in meadows and agricultural spaces), and therefore a single type of pollen. Urban bees are thus at an advantage as far as food sources are concerned, and therefore they gather more nectar and—likely related to this—survive better (65% winter survival against 40% for rural colonies).
- **Urban swarms need your help.** A natural swarm does not have a very good chance of survival. Only about a quarter of swarms make it through their first winter. In the city, it's likely harder. Bees need cavities of spe-

cific volumes and have requirements for the size and direction of the opening and a host of other things. We'll talk about all that in Part 2. Even in a forest, tree cavities that make good bee homes are hard to

Natural beekeeping?

We mentioned that this manual describes a "natural" approach to beekeeping, but let's be clear what this means. It means we will limit interventions in the hive, with only two invasive inspections per year. It means we will stay away from most pharmaceutical compounds for treating disease. And it means we will not try to prevent, by all means at our disposal, a colony from reproduction through swarming and rearing its own queens. What it does **not** mean is that we will let the colony work out all its problems alone. Remember how few swarms make it through their first winter: unmanaged colonies may be "natural" but don't do very well. Never forget that "natural" does not equate with "good"!

We do live in a time where "natural" beekeeping attracts much attention. In part this is because of the horrific bee mortality we are experiencing. It is easy to blame this on industrial modes of beekeeping and to suggest that going back to pre-industrial approaches will solve the problem. But one must be very careful drawing this conclusion. It sounds logical, but simply may not be true. As one blatantly obvious example: the straw skep may be the emblem of beekeeping and of the good old days, but it is one of the worst hive types ever invented. A colony in a skep could not be inspected or managed, the straw was a haven for parasites, and honey typically had to be harvested by killing the bees outright. There's a reason these things are illegal now. Older and simpler approaches are not necessarily better.

What "natural beekeeping" certainly does not mean to us is inventing new, supposedly "natural" approaches to keeping bees, approaches that often are anything but natural. Many authors have written about their attempts to get away from industrialized beekeeping and work out a better approach for hobby beekeepers. At times, unfortunately, these efforts are greatly misguided. Take the recent interest in the top-bar hive (see ***The original way of keeping bees,*** below). This beautiful horizontal hive model was developed for beekeeping in Africa and is totally appropriate for that setting. But in the US and Europe innovative beekeepers introduced it as a "natural" mode of keeping bees. This makes little sense. In contrast to African bees, our bees naturally nest in vertical cavities in trees, and there is nothing natural about putting them into a horizontal hive. Our bees need large supplies for winter, which African bees need not, and the top-bar hive is ill suited to storing large amounts of honey. Worse, some "natural" approaches to top-bar beekeeping force the bees to split their winter supplies into two sections, which makes it impossible for the bees to reach half their food during a cold spell.

Bees are highly versatile animals. They adapt to all kinds of settings, including top-bar hives in temperate zones. We have kept bees in those hives, and it was great fun. But it is not a "natural" situation at all for our bees.

So, let's be very clear what we mean when we say we will describe a natural approach to beekeeping. This book will not force a "natural" solution on the bees. Instead, we will, as much as possible, adapt **our** work flow to follow **their** natural tendencies. We will work "with the bees".

come by. For instance, only about 15% of natural tree cavities will meet the bees' volume requirements. In the city it is that much harder to find an appropriate space to live in. And even if the space is perfect for the bees, if their presence interferes with human occupation (and at times even if it does not) the bees are likely to be killed outright. Therefore, providing appropriate nesting sites for bee swarms helps them enormously, and provides you with free bees at the same time. The bee-keeper partnership was made for you.

Have people not thought of this before?

Of course, they have. Deep down, there is nothing particularly novel about this book. The techniques described here have been practiced in various forms for thousands of years in different parts of the world, although the scientific approach to attracting swarms is relatively new. We have begun to learn from the wild bees. For example, *The Lives of Bees* by Thomas Seeley (see the ***Reading List***) describes the biology of feral colonies and how we can apply some lessons from those findings to our beekeeping practices. Other smart people have looked at and written about the issues facing the hobby beekeeper who doesn't want to work in an industrial mode. *The Backyard Beekeeper* by Kim Flottum (again see the ***Reading List***) is an example: an excellent brief text about hobby beekeeping (he appropriately quotes James Tew: "Most people get into beekeeping because of their curiosity about bees, but they leave beekeeping because of the nightmare of harvesting honey"). *The Backyard Beekeeper* advocates several approaches that you will find in this book as well.

What sets our manual apart is that it pulls together several tested techniques and approaches into a coherent system, one that will allow you to enjoy having a few hives, and do so in a natural, simple, and inexpensive way. This is not stuff that was dreamed up as a novel approach to the craft of beekeeping (some texts on "natural beekeeping" suffer from such wishful thinking). **All you will find here are time-tested, established techniques, brought together into a system that works well for the modern backyard beekeeper.**

What is NOT in this book?

We have tried not to write about things that you can easily find elsewhere on the web, and about which a fair amount of agreement exists in the beekeeping community. The kind of information where you will not get a dozen different answers to your question when you do a Google search. Beekeepers agree on how long it takes for a worker bee to grow from an egg into an adult bee—so

you will not find the life cycle of the honeybee described in this book. Beekeepers do not agree at all on whether one should use queen excluders—so that is a topic we will discuss.

Similarly, we do not include an encyclopedia of bee diseases. Plenty of books deal with that topic, and again the web is an excellent resource. We will deal only with a couple of common diseases that you should take preventive action against (varroa mites and small hive beetles).

What then IS in this book?

We thought you'd never ask! Here is the briefest of overviews of what we will cover.

- ***Part 1: The Novice Beekeeper,*** is an introduction that provides the beginning beekeeper with essential information on what you need to get started with the craft. If you have some experience in beekeeping, you could skip this and go right on to ***Part 2***. But we would not recommend doing that. That is because we also describe in ***Part 1*** the specific reasons behind some of our practice choices (why, for example, our hives consist only of 8-frame medium hive bodies). Therefore, even experienced beekeepers might still want to skim through it.

- After this overview of basics, we will follow the flow of time. We start the full description of the bee-keeper partnership in spring, when bees swarm. ***Part 2: Swarming Bees, and How to Charm Them,*** explains the swarming process and teaches you how to "charm" swarms so you can attract them to a box you place, and then move them into a hive. Obtaining your bees this way is a key feature of our technique.

- ***Part 3: Colony Care,*** describes the initial management of your newly hived swarm. It explains our approaches in detail: bee-friendly, minimal impact methods that you will be employing throughout your beekeeping work. This section will bring us to the end of the honey flow, somewhere near the beginning of summer.

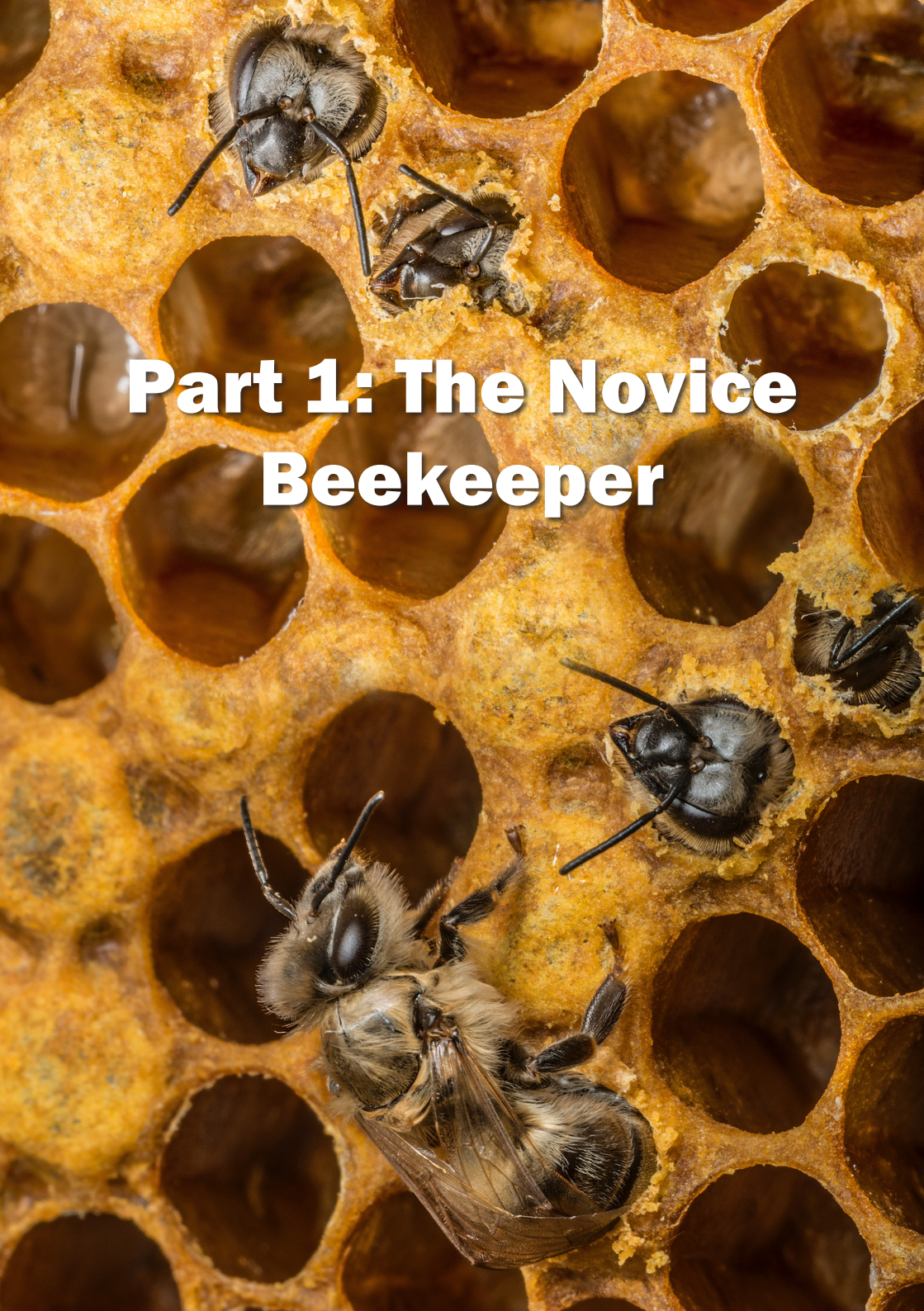
- Come summer, you can take care of your new swarm as if it were an established colony. Therefore, where the first two sections of the book focus on your new swarm and its management, ***Part 4: Through the Year,*** applies to both new and established colonies. It forms a kind of beekeeping calendar. It will guide you through the whole beekeeping year and tell you how to take care of your colonies in a bee-friendly manner, using the methods described in ***Part 3***. We will start right after the honey flow and take you through the entire year until next

year's honey flow and honey extraction. The processes described in this section are what you will use for each year of your beekeeping career.

And with those questions out of the way, let's get going!

Beekeeping through space and time

It is always too easy to look at the way things are done in the here and now as the only obvious way that things can be done. This is certainly true for beekeeping, where the Langstroth hive has led to serious (though useful) standardization. But knowing only one single approach tends to stop experiment and progress. Beekeeping can and has been done in a wild variety of ways in various times and places. To give you a flavor of the different approaches to the craft, we have added frequent boxes like this one with tidbits of information on beekeeping around the world and through the ages.



Part 1: The Novice Beekeeper

As discussed in the ***Introduction,*** as a new beekeeper you have some special issues to consider if you want to walk the path of the bee-keeper partnership. These issues mainly concern our approach to obtaining our bees. We depend on swarms instead of buying them.

The biggest issue in starting out on your career as a bee-keeper partner is that no swarms may show up. To catch swarms, they must come from somewhere. They come either from hives (most of the time) or from wild bees (of which there may not be many in your area). If you are just starting out keeping bees and no one else in your area has hives, there simply may not be any swarms around. And if no swarms appear, you just lost a year in starting this lovely hobby. Do you really want to run that risk?

Also, plenty of people can help you get started with bees you have bought, while it is not (yet) easy to find mentors for swarm-based beekeeping. And is it such a great idea for someone who has never dealt with bees to start hoisting swarm boxes into trees or shaking swarms from branches without a more experienced person standing by to help?

Given these two issues, might it not be better to start with the tried-and-true method of buying a bunch of bees and a queen, and getting them established using techniques that every beekeeper can teach you?

It probably is. **For most new beekeepers, it may be easier (though more expensive) to start out with bought bees.** You can still apply all the bee-keeper partnership approaches we will describe in *Part 3* and *Part 4*, and once you have a little experience you can transition to charming swarms as described in *Part 2*.

To help you understand what it means to start with bought bees, we will provide in this first part of the book some basic information on the process of buying bees. Several books in the *Reading List* give more details. And as those bought bees need to go somewhere and be managed, we will also describe here the equipment you will need to keep bees as a bee-keeper partner.

Packages and Nucs

Bought bees come in two types.

- **The first type is called a "package", and it is exactly that.** It consists of a small box, partly covered with hardware cloth, that contains about three pounds of bees. Inside dangles a much smaller box (a "queen cage") containing a mated queen. Finally, there is a can of sugar water inside to keep the bees alive while in transport. You typically order packages months in advance and then pick them up somewhere on a specific date mid-spring. They also can be shipped through the mail. Bee package prices unfortu-

nately have increased terribly over the past years. At the time of writing a package will set you back about $175 in the US or £150 in the UK.

Fig. 1.1. A package of bees. The circular metal plate at the top is the lid of the can with feed. The queen cage is hidden inside the clump of bees. (Courtesy of Scottsville Supply Company)

Once you have your package, you install it into a hive. This is not a matter of just dumping them in. The queen that comes with the bees is not their queen: it is a queen raised separately, and not related to the bees in the package. Therefore, the bees will need to become habituated to her. You cannot just drop her in with the bees; she would be killed. Instead, you need to place her inside the hive, but keep her inside her queen cage, so that the other bees cannot get at her. The bees gradually will become accustomed to her smell, and through the clever device of a fondant plug in the little cage, which the bees will slowly eat away, she will be released in a few days. By then, hopefully, they have accepted her, and she is ready to start laying eggs.

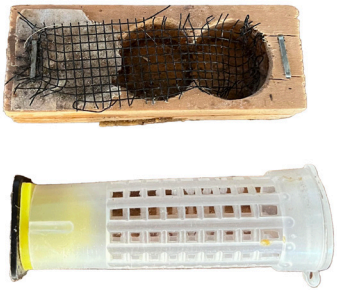


Fig. 1.2. Typical queen cages: the top shows a classic wooden version, the bottom a more modern plastic one. (Courtesy of Patti Bowen Hollinger)

First time package installation is best attempted with someone who has done it before. It is a somewhat complicated job, and many things can go wrong if it is not done cor-

rectly. Other things can go wrong even if you install the package just fine, the most problematic being when the bees in the package do not accept the queen and kill her once she comes out of the queen cage. Packages take a long time to grow into a real colony. The bees will need to build comb with cells for the queen to lay eggs in, and once she is accepted and starts laying, it will still be three weeks before the first bees emerge. Broadly speaking, it will take about a month before the package can start growing at all.

- **The second type of bought bees is a "nuc",** short for "nucleus colony". This is just a very small bee colony, typically four to six frames (we'll talk about frames later), in a special small "nuc box". It has a queen that is already accepted by the bees and is laying eggs, and it should have brood in all stages. All it needs to do is grow out into a larger colony. Nucs are more work for bee suppliers to prepare, and they are therefore pricier. At the time of writing a nuc costs around $200 in the US and £300 in the UK—if you can find them at all, since supplies often run out. As with packages, you typically order well in advance and pick them up on a specified date in spring. They will be available later than packages are, as it takes time to grow out the small colony. Installing a nuc is easy. You move the frames into a hive, fill the rest of the hive box with additional frames, and you are done.

  For the beekeeper who wants to use only medium boxes (see ***Beehives*** below) one issue with nucs is that it may not be easy to find them for sale on medium frames; most will have been raised on deep frames.

Fig. 1.3. A five-frame nucleus colony in a nuc box. (Courtesy of Scottsville Supply Company)

If you do decide to start with a package or nuc, try to get one that was raised in the area where you live. Oftentimes nucs and packages are shipped from far away. In the US they typically come from the southern states. As spring weather arrives earlier there, suppliers can get nucs and packages

ready at earlier dates. However, if you live at a different latitude, those bees may not be genetically habituated to your climate and may not perform optimally. Also, queens raised in the southern states may have mated with and carry some of the genes of the Africanized honeybee, which could possibly make their offspring more defensive. In fact, a fraction of the wild bees living as far north as New York state were found to carry such genes, likely because they are descended from queens bred in the south and then shipped north in nucs or packages. A final disadvantage of buying bees from far away is that it entails trucking them across the country, which is how diseases are spread. Therefore, if you can find locally raised bees, take those!

From deep to medium

Let's say you have been keeping bees for a while with a classic deep-and-medium setup, and now you want to transition to medium-only. Or the only nuc you can get your hands on is on deep frames, and you want to set it up in a medium hive. How do you make that transition from deep to medium?

It is not easy, for a deep frame absolutely does not fit in a medium box!

For the nuc, we would strongly recommend not buying it. There really is no convenient way to make that transition. If you are stuck with that deep nuc, your best bet would be to buy one single 8-frame deep box and a few deep frames. Transfer the nuc to that deep box and fill the remaining space with deep frames. It will be your bottom box, and everything above will be mediums. In other words, you have now turned it into a classic deep-and-medium setup.

To change that to our recommended medium-only system, do the following. In late fall, when there is no brood, move that deep box to the top of the hive, and put an escape board beneath it. The bees will leave the box, and after a few days you can remove it. The deep box can still be useful, for it will make an excellent swarm trap.

You can use the same approach to switch an established deep-and-medium hive to medium-only.

Equipment

In this section, we will help the novice beekeeper understand and select the stuff needed to keep bees. It may be less than you thought.

We will discuss beehives, and where to put them, as well as other tools and gadgets.

Beehives

Whether you start with a nuc or package, or whether you decide to attract a swarm, you will need to place it into a hive. Let's look at hives and hive parts and give you some estimates of the associated costs.

Bees evolved in central Africa, and over millions of years they moved north into the temperate zones of Europe, adapting their behavior as they moved.

A note on hive types

Although all standard hives currently in use are designed around the same principles, various countries have their own preferred models. In the US, for example, this is the Langstroth hive. In the UK it is the Improved National Beehive. Other countries have their own favorites. Since we can't describe all of them in detail, in this book we will be using the US Langstroth hive as a model. Most of what we say about the Langstroth hive will be directly applicable to other hive designs, but if you use one of those different types you will need to look up some important items, such as the volume of space in a single box. And for some design differences, such as how bottom boards are constructed, you may have to adapt what we describe here.

From a pattern of nesting in small rock crevices and regularly moving nest sites toward places where flowers bloomed, they changed their habits to nesting in vertical tree cavities and staying there for years. During the ice ages they evolved the mechanisms to build up, inside those tree cavities, substantial supplies of honey to make it through cold and barren winters, something they did not have to worry about in Africa.

Thomas Seeley, in his book *The Lives of Bees,* aptly describes a bee nest as "a survival tool that extends beyond the bees' own bodies." A typical natural cavity used by bees is narrow (9 inches/23 cm) and tall (5 feet/150 cm), with a volume of 10 to 12 gallons (38-45 liters). Within that tree cavity bees create long, parallel sheets of wax comb that hang vertically from the ceiling and hold the thousands upon thousands of small hexagonal cells used to rear brood and store food. The wax comes from special glands in the abdomen of the workers. They attach the sheets of comb to the sides of the cavity for support, leaving spaces to allow movement through the nest. On average, they create eight sheets with a total surface of thirteen square feet (about one square meter), equivalent to somewhat less than the frames held in two 8-frame medium boxes. (And if that doesn't mean a thing to you, read on! We're just about to describe the parts of a hive.)

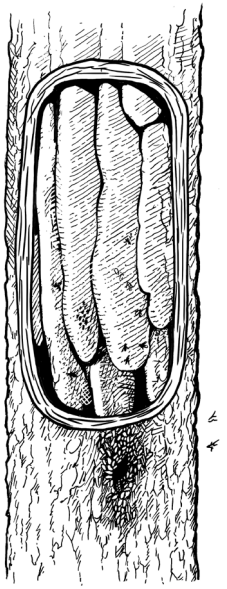


Fig. 1.4. A bee nest inside a tree, showing sheets of comb constructed inside the cavity.

In order to hold happy bees in artificial hives, we need to duplicate as much as possible this natural arrangement in a tree. People have agonized for centuries how best to accomplish this,

Other types of nests

Not all species of bees build their nests the same way. Some relatives of our honeybees have evolved quite different approaches to constructing a home.

The most dramatic nest (if one can call it that) is likely that of the giant honeybee, *Apis dorsata*. This species lives in southeast Asia, and as its name suggests it is substantially larger than our honeybee, *Apis mellifera*. The giant bee can be over an inch (2.5 cm) in length, about twice as long as one of our worker bees. An *Apis dorsata* nest consists of one single giant piece of comb that hangs in the open, something that the weather in their area allows. It can be up to 60 inches/1.5 m long and 30 inches/75 cm tall. Typically, it is constructed under rocky overhangs, and more often than not many *Apis dorsata* colonies build their nests close to each other.

Fig. 1.5: A nest of Apis dorsata, the giant honeybee, hanging from a porch roof.

The comb is typically invisible, as it is covered with thick layers of bees, heads pointing inward, tails (with stingers!) pointing out.

At the other end of the spectrum are the stingless bees, with more than 500 known species. These bees do nest in tree cavities, like our honeybees, but also underground and in other spaces. They store their honey not in cells on comb, but in small globular "pots" made of wax, which surround a brood area—a completely different architecture than honeybee nests.

Stingless bee honey comes in small amounts but is highly prized (and priced: it can easily run to $50/£40 a pound). In central America and other areas where stingless bees thrive, they are kept for their honey production, often in small wooden boxes.

Fig. 1.6: The nest of a stingless bee colony. The honey pots are clearly visible.

and the eventual solution, which works tolerably well, has been to devise a system where this tall vertical cavity is separated into segments that we can manipulate individually. Thus, our beehives consist of stacked boxes. Instead of the long parallel sheets of wax comb that bees build in nature, we have to give them shorter pieces, each the height of a box. Thus, each box contains a number of parallel frames that hold the comb. They almost touch their counterparts in boxes above and below—almost, but not quite. They are

Bee space

The absolute key to allowing the construction of practical hives with movable frames was the discovery of bee space. Any space between two parts of a hive that are less than a quarter inch apart will be closed off by bees, using a thick tree resin called propolis. Bees also use this, for example, to fill small cracks in the walls, and to keep the interior of the hive dry and free of drafts. Propolis is so sticky that taking apart two pieces of wood that are "propolized" together can be almost impossible. In contrast, bees use any space greater than about half an inch to build some more comb. This is easier to pull apart but doing so results in a mess of mixed honey and half-grown larvae. But here is the trick: space between a quarter inch and a half inch is not filled in. This is the bee space. In natural nests these areas of bee space allow bees to move around their hives.

The discovery of bee space is often credited to the reverend Lorenzo Langstroth in the eighteen hundreds, but in fact the need for exact spacing of hive parts had been realized well before his time (e.g. Abbott della Rocca in 1790 and François Huber in 1792). It was Langstroth, however, who realized that it should be possible to build a hive where all pieces that needed to be manipulated by the beekeeper would be separated by bee space, so that none of them would be stuck to any other. He devised a system with frames that were suspended on ledges and had appropriate bee space all around them on all sides. The bees would not attach anything to those frames, and they could be easily removed. "I could scarcely refrain from shouting out my 'Eureka' in the open streets," he wrote in his diary. And he had a right to be excited, for it was the invention that changed everything. There have been many modest modifications, but the Langstroth hive has become the overwhelmingly most common type of beehive in the temperate zones.

separated by a specific "bee space" (see the box below). For the bees it seems to make little difference that the comb is broken up this way. For us it makes all the difference in the world, as it allows us access to every part of the hive.

Selected, happenstance, or irrelevant?

We still know so little about what bees look for in their homes, and which things about their nest or hive matter to them. For answers, people look at natural bee nests. We must keep in mind, though, that what we find there does not automatically tell us what bees look for. For example, we know that the typical size of a natural nest is around 10 gallons. But that in and of itself does not automatically mean that bees actively search for such a size. It might just indicate that most tree cavities happen to be of that volume, and bees just take what they can find. It is therefore so important that studies have been done determining the attractiveness to swarms of nest boxes with various properties. Those show us if bees actively look for those properties. We do now know that bees indeed prefer boxes with a volume around 10 gallons: they do not nest in boxes that are much smaller or much larger. The same holds for size of the opening, or position of the opening in the box. But we do not yet know, for example, if the thick insulation of natural bee nests is just something that comes

with the right sized cavity in a big tree, or whether it is something specifically selected by the bees. If it is the first, insulating hives may not at all be needed, whereas if it is the second, extra insulation in cold weather might be very important.

Some nest properties may be actively selected by bees but are no longer relevant when colonies are housed in hives. Opening size and height above the ground, for example. Bees like their nests high and with small entrances, and beekeepers instead place them close to the ground and provide a larger entrance (so bees can efficiently go in and out when collecting nectar). Is this a problem? Likely not. Bee preferences for these parameters are primarily to provide safety against predators, which are luckily not a significant issue in our apiaries. Putting hives on the ground and with large openings may not be a problem even if it's not what the bees would choose themselves. And if it gets too cold, we will make the opening smaller for them to prevent heat loss.

We must remain aware, though, that in adapting the bee nest model to a system we can work with, beekeepers also introduced some dramatic changes. What may have most impact on the bees is the enormous volume people tend to give them, much more than colonies choose in the wild. Remember that the typical wild bee nest is about 10 gallons/40 liters in volume. Typical hives can be many times as large! It is one reason why in our system we don't like to make our hives too voluminous. Also, hives are nowhere as well insulated as natural nests. In one study the average wall thickness in natural nests was about 6 inches (15 cm), and a typical tree nest is likely five times better insulated than one of our hives. This, in turn, means that in a tree nest, bees do not need to stick as tightly together in winter to stay warm, and can keep moving around the hive and accessing food. In making beekeeping easy for people, we have neglected some of the factors that bees themselves find important.

With that background, the typical anatomy of a beehive, working up from the bottom, is as follows:

- **We first need some kind of stand, to keep the hive off the ground.** This can be anything from a few cinderblocks to commercially built plastic devices. It does not matter much what you use, as long as it is solid, keeps the hive some distance from the ground, and is positioned so that the hive floor is horizontal. Even though bees much prefer a high entrance when searching for real estate, once they are settled, a colony cares little about the height of their dwelling. In contrast, height matters a lot to us: it is quite important that you can work the hive without hurting your back. Four or five boxes stacked up makes a fairly high tower, and unfortunately the heaviest ones (with honey) are on top. **Therefore, do not make the stand much higher than about a foot off the ground,** or

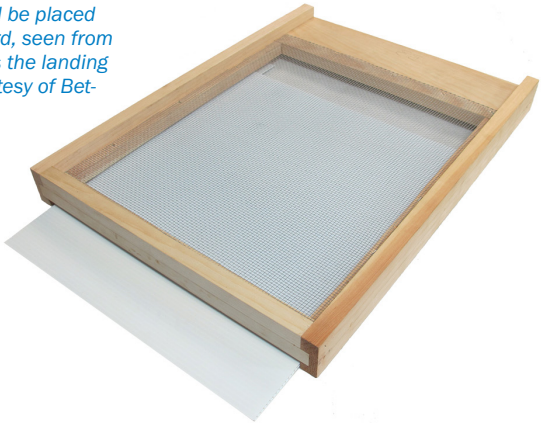
those top boxes will be almost out of reach.

- **On that stand sits the floor of the hive.** These floors come in a variety of types. The version we will use consists of two pieces. At the bottom is a board (logically named the "bottom board"), and on top of it sits what is basically a piece of hardware cloth in a frame (the "screen"). At the back of the hive a gap is left between these two pieces of flooring, where you can slide in a shallow tray. At the front of the hive a gap is left between the screen and the first box that is stacked on it. This is the entrance for the bees. This whole assembly is referred to as a "screened bottom board with space for a varroa tray". You can also get these two separate pieces built into a single unit.

Fig. 1.7. A bottom board, seen from the back. Placed on it is an entrance reducer that typically comes with the board. We tend not to use those. (Courtesy of Betterbee.com)

Why this somewhat complicated floor system? In particular, why the screen? **There are two reasons. The first is ventilation.** A screened bottom board system allows fresh air to come into the gap in the back and move up through the screen into the hive. This supplements air coming in through the front entrance. **The second reason for a screened bottom**

Fig. 1.8. A screen that will be placed on top of the bottom board, seen from the back. At the far end is the landing board for the bees. (Courtesy of Betterbee.com)



board, more important, is that it forms the basis for our main form of pest control. As mentioned, in between the bottom board and the screen you can slide a shallow plastic tray. You will fill that tray with a small amount of mineral oil (or diatomaceous earth). The holes in the screen are too small to let a bee through, but the two main pests (varroa mites and small hive beetles) definitely can and do fall out of the hive through the screen—and then they get stuck in the oil and die.

Fig. 1.9. A varroa tray, which you will fill with mineral oil or diatomaceous earth and place between the bottom board and the screen. (Courtesy of Betterbee.com)

As an aside, using a screened bottom board also eliminates a requirement you will frequently see mentioned: that the hive be positioned leaning slightly forward. With a solid bottom board this is necessary so that any rainwater will run out. With a screened board it does not matter, as the water will run right down through the screen. You can set your hive proudly upright. However, keep in mind that water running through the screen will wind up in your varroa tray and convert it into a water trap (which doesn't work anywhere as well). After heavy rainfall you may want to check your traps to make sure the oil has not been washed out.

- **On this screened bottom board, you stack boxes, building up a stylized version of a tree cavity.** The number of boxes (or "hive bodies") will depend on the time of year, as we will describe in later parts of this book. It will typically be between three and six. Like most things in beekeeping these boxes come in multiple sizes:
    - **First, there are variants that hold different numbers of frames.** The standard is 10-frame, but 8-frame sizes are also readily available.
    - **Second, there are boxes of various heights (confusingly referred to as "depth").** Traditionally, one uses deep boxes (ap-

propriately called "deeps" and 9 ⅝ inches/24.5 cm high) for the first two above the bottom board assembly. This is where the brood nest is, and the deeps are therefore sometimes referred to as "brood boxes". Above these come boxes for honey storage, and those are less deep: 6 ⅝ inches/16.8 cm. The main reason for using smaller boxes is weight. A 10-frame deep full of honey would weigh 80 to 90 pounds (36-41 kg)! These smaller boxes are called "mediums", because there is yet a third type ("shallows") that is rarely used in practice. And just to create more confusion, mediums are also referred to as "supers", as they are placed on top of the brood boxes.

Fig. 1.10. An 8-frame medium box with wooden frames.

Propolis inside the hive

Wild bees, living in tree cavities, tend to cover the inner wall of the cavity with propolis. They likely do this because that inner wall is rough, has crevices where pests can hide, and may even have areas that are wet and rotten. Bees living in our beautifully sawed hives do not have these problems, and therefore do not spread propolis over the inner surfaces.

But propolis is an interesting substance. It has antibacterial properties, and studies have shown that if we make bees coat the inside of their hives with the compound it benefits their immune system. Although much more research is needed, something is to be said for inducing your bees to apply a coat of propolis to the inside of the hive bodies. It is hard to see any downside.

How do you get them to do this? All that is needed is to roughen up the inside of the hive boxes, which will stimulate the bees to "propolize" the walls.

Which of these varied options should you use? 10-frame boxes may be fine for commercial beekeepers with motorized equipment, but their weight can be problematic for the hobby beekeeper. A 10-frame medium full of honey weighs 65 to 75 pounds (29-34 kg). **The 8-frame box is thus more suited to hobby beekeeping. It probably is also more natural.** Remember that the typical tree cavity is only 8 inches (20 cm) wide? All our boxes are way wider than that, but the 8-frame comes closer than the 10-frame. And natural bee nests typically have about eight combs, so here again 8-frame boxes may come closer to the natural layout. As to depth, each of the three box types—deeps, mediums, and shallows—takes its own size of frame, and there's the rub. **You cannot exchange frames between boxes of different height.** A deep frame will not fit into a medium box, and if you put a medium frame into a deep box the bees will build comb to fill the extra room at the bottom. You have violated the bee space. Therefore, **the most elegant solution for the hobby beekeeper is to do away with the various depth sizes and standardize to a single one: the medium. Only use 8-frame medium boxes and medium frames.** This approach has been advocated by others as well, and it is a simple yet powerful idea. It makes it really easy to move parts around hives as needed, and you will be working with boxes of manageable weight.

And there we are: we will build our hives using only 8-frame mediums. We will not need to talk about brood boxes or supers—they will all be the same. You can buy these boxes assembled or unassembled. The latter are cheaper and would therefore be preferred. But if you have the money and want to make life a bit easier when just starting out it may be worth paying a little more to get the assembled type, so there's one less thing to learn.

- Inside the boxes go frames, and inside the frames sits something that bees can build their cells on. This is called "foundation". You will not be surprised to hear that once again frames and foundation come in several versions.
    - **The classic frame is wood, with a foundation of wax which already has an imprint of hexagonal cell bases,** to help guide the bees in their construction. You can buy these frames fully assembled or unassembled. In the latter case you hammer the wooden pieces together and load the foundation in. As with boxes, it may be easiest for the new beekeeper to start with pre-assembled frames, and then move to the (somewhat cheaper) hand assembly. When you get to that point you will