

## ORGANIC GARDENER'S COMPOSTING

by Steve Solomon and other vermicomposters talking on the internet!

### VERMICOMPOSTING

It was 1952 and Mr. Campbell had a worm bin. This shallow box--about two feet wide by four feet long--resided under a worktable in the tiny storeroom/greenhouse adjacent to our grade school science class. It was full of what looked like black, crumbly soil and zillions of small, red wiggly worms, not at all like the huge nightcrawlers I used to snatch from the lawn after dark to take fishing the next morning. Mr. Campbell's worms were fed used coffee grounds; the worms in turn were fed to salamanders, to Mr. Campbell's favorite fish, a fourteen-inch long smallmouth bass named Carl, to various snakes, and to turtles living in aquariums around the classroom. From time to time the "soil" in the box was fed to his lush potted plants.

Mr. Campbell was vermicomposting. This being before the age of ecology and recycling, he probably just thought of it as raising live food to sustain his educational menagerie. Though I never had reason to raise worms before, preparing to write this book perked my interest in every possible method of composting. Not comfortable writing about something I had not done, I built a small worm box, obtained a pound or so of brandling worms, made bedding, added worms, and began feeding the contents of my kitchen compost bucket to the box.

To my secret surprise, vermicomposting works just as Mary Appelhof's book *Worms Eat My Garbage* said it would. Worm composting is amazingly easy, although I admit there was a short learning curve and a few brief spells of sour odors that went away as soon as I stopped overfeeding the worms. I also discovered that my slapdash homemade box had to have a drip catching pan beneath it. A friend of mine, who has run her own in-the-house worm box for years, tells me that diluting these occasional, insignificant and almost odorless dark-colored liquid emissions with several parts water makes them into excellent fertilizer for house plants or garden.

It quickly became clear to me that composting with worms conveniently solves several recycling glitches. How does a northern homeowner process kitchen garbage in the winter when the ground and compost pile are frozen and there is no other vegetation to mix in? And can an apartment dweller without any other kind of organic waste except garbage and perhaps newspaper recycle these at home? The solution to both situations is vermicomposting.

Worm castings, the end product of vermicomposting, are truly the finest compost you could make or buy. Compared to the volume of kitchen waste that will go into a worm box, the amount of castings you end up with will be small, though potent. Apartment dwellers could use worm castings to raise magnificent house plants or scatter surplus casts under the ornamentals or atop the lawn around their buildings or in the local park.

In this chapter, I encourage you to at least try worm composting. I also answer the questions that people ask the most about using worms to recycle kitchen garbage. As the ever-enthusiastic Mary Applehof said:

"I hope it convinces you that you, too, can vermicompost, and that this simple process with the funny name is a lot easier to do than you thought. After all, if worms eat my garbage, they will eat yours, too."

### Locating the Worms

The species of worm used for vermicomposting has a number of common names: red worms, red wigglers, manure worms, or brandling worms. Redworms are healthy and active as long as they are kept above freezing and below 85°. Even if the air temperature gets above 85°, their moist bedding will be cooled by evaporation as long as air circulation is adequate. They are most active and will consume the most waste between 55-77°--room temperatures. Redworms need to live in a moist environment but must breathe air through their skin. Keeping their bedding damp is rarely the problem; preventing it from becoming waterlogged and airless can be a difficulty.

In the South or along the Pacific coast where things never freeze solid, worms may be kept outside in a shallow shaded pit (as long as the spot does not become flooded) or in a box in the garage or patio. In the North, worms are kept in a container that may be located anywhere with good ventilation and temperatures that stay above freezing but do not get too hot. Good spots for a worm box are under the kitchen sink, in the utility room, or in the basement. The kitchen, being the source of the worm's food, is the most convenient, except for the danger of temporary odors.

If you have one, a basement may be the best location because it is out of the way. While you are learning to manage your worms there may be occasional short-term odor problems or fruit flies; these won't be nearly as objectionable if the box is below the house. Then too, a vermicomposter can only exist in a complex ecology of soil animals. A few of these may exit the box and be harmlessly found about the kitchen. Ultra-fastidious housekeepers may find this objectionable. Basements also tend to maintain a cooler temperature in summer. However, it is less convenient to take the compost bucket down to the basement every few days.

## Containers

Redworms need to breathe oxygen, but in deep containers bedding can pack down and become airless, temporarily preventing the worms from eating the bottom material. This might not be so serious because you will stir up the box from time to time when adding new food. But anaerobic decomposition smells bad. If aerobic conditions are maintained, the odor from a worm box is very slight and not particularly objectionable. I notice the box's odor only when I am adding new garbage and get my nose up close while stirring the material. A shallow box will be better aerated because it exposes much more surface area. Worm bins should be from eight to twelve inches deep.

I constructed my own box out of some old plywood. A top is not needed because the worms will not crawl out. In fact, when worm composting is done outdoors in shallow pits, few redworms exit the bottom by entering the soil because there is little there for them to eat. Because air flow is vital, numerous holes between 1/4 and 1/2 inch in diameter should be made in the bottom and the box must then have small legs or cleats about 1/2 to 3/4 of an inch thick to hold it up enough to let air flow beneath. Having a drip-catcher--a large cookie tray works well--is essential. Worms can also be kept in plastic containers (like dish pans) with holes punched in the bottom. As this book is being written, one mail-order garden supply company even sells a tidy-looking 19" by 24" by about 12" deep green plastic vermicomposting bin with drip pan, lid, and an initial supply of worms and bedding. If worm composting becomes more popular, others will follow suit.

Unless you are very strong do not construct a box larger than 2 x 4 feet because they will need to be lifted from time to time. Wooden boxes should last three or four years. If built of plywood, use an exterior grade to prevent delamination. It is not advisable to make containers from rot-resistant redwood or cedar because the natural oils that prevent rotting also may be toxic to worms. Sealed with polyurethane, epoxy, or other non-toxic waterproofing material, worm boxes should last quite a bit longer.

How big a box or how many boxes do you need? Each cubic foot of worm box can process about one pound of kitchen garbage each week. Naturally, some weeks more garbage will go into the box than others. The worms will adjust to such changes. You can estimate box size by a weekly average amount of garbage over a three month time span. My own home-garden-supplied kitchen feeds two "vegetablearian" adults. Being year-round gardeners, our kitchen discards a lot of trimmings that would never leave a supermarket and we throw out as "old," salad greens that are still fresher than most people buy in the store. I'd say our 2-1/2 gallon compost bucket is dumped twice a week in winter and three times in summer. From May through September while the garden is "on," a single, 2 foot x 4 foot by 12 inch tall (8 cubic foot) box is not enough for us.

## Garbage Can Composting

Here's a large-capacity vermicomposting system for vegetablearians and big families. It might even have sufficient digestive capacity for serious juice makers. You'll need two or three, 20 to 30 gallon garbage cans, metal or plastic. In two of them drill numerous half-inch diameter holes from bottom to top and in the lid as well. The third can is used as a tidy way to hold extra dry bedding.

Begin the process with about 10 inches of moist bedding material and worms on the bottom of the first can. Add garbage on top without mixing it in and occasionally sprinkle a thin layer of fresh bedding.

Eventually the first can will be full though it will digest hundreds of gallons of garbage before that happens. When finally full, the bulk of its contents will be finished worm casts and will contain few if any worms. Most of the remaining activity will be on the surface where there is fresh food and more air. Filling the first may take six months to a year. Then, start the second can by transferring the top few inches of the first, which contains most of the worms, into a few inches of fresh bedding on the bottom of the second can. I'd wait another month for the worms left in the initial can to finish digesting all the remaining garbage. Then, you have 25 to 30 gallons of worm casts ready to be used as compost.

Painting the inside of metal cans with ordinary enamel when they have been emptied will greatly extend their life. Really high-volume kitchens might run two vermicomposting garbage cans at once.

## Bedding

Bedding is a high C/N material that holds moisture, provides an aerobic medium worms can exist in, and allows you to bury the garbage in the box. The best beddings are also light and airy, helping to maintain aerobic conditions. Bedding must not be toxic to worms because they'll eventually eat it. Bedding starts out dry and must be first soaked in water and then squeezed out until it is merely very damp. Several ordinary materials make fine bedding. You may use a single material bedding or may come to prefer mixtures.

If you have a power shredder, you can grind corrugated cardboard boxes. Handling ground up cardboard indoors may be a little dusty until you moisten it. Shredded cardboard is sold in bulk as insulation but this material has been treated with a fire retardant that is toxic. Gasoline-powered shredders can also grind up cereal straw or spoiled grass hay (if it is dry and brittle). Alfalfa hay will decompose too rapidly.

Similarly, shredded newsprint makes fine bedding. The ink is not toxic, being made from carbon black and oil. By tearing with the grain, entire newspaper sections can rapidly be ripped into inch-wide shreds by hand. Other shredded paper may be available from banks, offices, or universities that may dispose of documents.

Ground-up leaves make terrific bedding. Here a power shredder is not necessary. An ordinary lawnmower is capable of chopping and bagging large volumes of dry leaves in short order. These may be prepared once a year and stored dry in plastic garbage bags until needed. A few 30-gallon bags will handle your vermicomposting for an entire year. However, dry leaves may be a little slower than other materials to rehydrate.

Peat moss is widely used as bedding by commercial worm growers. It is very acid and contains other substances harmful to worms that are first removed by soaking the moss for a few hours and then hand-squeezing the soggy moss until it is damp. Then a little lime is added to adjust the pH.

## Soil

Redworms are heat-tolerant litter dwellers that find little to eat in soil. Mixing large quantities of soil into worm bedding makes a very heavy box. However, the digestive system of worms grinds food using soil particles as the abrasive grit in the same way birds "chew" in their crop. A big handful of added soil will improve a worm box. A couple of tablespoonfuls of powdered agricultural lime does the same thing while adding additional calcium to nourish the worms.

## Redworms

The scientific name of the species used in vermicomposting is *Eisenia foetida*. They may be purchased by mail from breeders, from bait stores, and these days, even from mail-order garden supply companies. Redworms may also be collected from compost and manure piles after they have heated and are cooling.

Nightcrawlers and common garden worms play a very important part in the creation and maintenance of soil fertility. But these species are soil dwellers that require cool conditions. They cannot survive in a shallow worm box at room temperatures.

Redworms are capable of very rapid reproduction at room temperatures in a worm box. They lay eggs encased in a lemon-shaped cocoon about the size of a grain of rice from which baby worms will hatch. The cocoons start out pearly white but as the baby worms develop over a three week period, the eggs change color to yellow, then light brown, and finally are reddish when the babies are ready to hatch. Normally, two or three young worms emerge from a cocoon.

Hatchlings are whitish and semi-transparent and about one-half inch long. It would take about 150,000 hatchlings to weigh one pound. A redworm hatchling will grow at an explosive rate and reach sexual maturity in four to six weeks. Once it begins breeding a redworm makes two to three cocoons a week for six months to a year; or, one breeding worm can make about 100 babies in six months. And the babies are breeding about three months after the first eggs are laid.

Though this reproductive rate is not the equal of yeast (capable of doubling every twenty minutes), still a several-hundred-fold increase every six months is amazingly fast. When vermicomposting, the worm population increase is limited by available food and space and by the worms' own waste products or casts. Worm casts are slightly toxic to worms. When a new box starts out with fresh bedding it contains no casts. As time goes on, the bedding is gradually broken down by cellulose-eating microorganisms whose decay products are consumed by the worms and the box gradually fills with casts.

As the proportion of casts increases, reproduction slows, and mature worms begin to die. However, you will almost never see a dead worm in a worm box because their high-protein bodies are rapidly decomposed. You will quickly recognize worm casts. Once the bedding has been consumed and the box contains only worms, worm casts, and fresh garbage it is necessary to empty the casts, replace the bedding, and start the cycle over. How to do this will be explained in a moment. But first, how many worms will you need to begin vermicomposting?

You could start with a few dozen redworms, patiently begin by feeding them tiny quantities of garbage and in six months to a year have a box full. However, you'll almost certainly want to begin with a system that can consume all or most of your kitchen garbage right away. So for starters you'll need to obtain two pounds of worms for each pound of garbage you'll put into the box each day. Suppose in an average week your kitchen compost bucket takes in seven pounds of waste or about one gallon. That averages one pound per day. You'll need about two pounds of worms.

You'll also need a box that holds six or seven cubic feet, or about 2 x 3 feet by 12 inches deep. Each pound of worms needs three or four cubic feet of bedding. A better way to estimate box size is to figure that one cubic foot of worm bin can digest about one pound of kitchen waste a week without going anaerobic and smelling bad.

Just remember, keep the cycle going by allowing time for the worms to move to a new eating spot after reducing, or composting the food, and new bedding ready to replace the composted soil after removal.

Redworms are small and consequently worm growers sell them by the pound. There are about 1,000 mature breeders to the pound of young redworms. Bait dealers prefer to sell only the largest sizes or their customers complain. "Red wigglers" from a bait store may only count 600 to the pound. Worm raisers will sell "pit run" that costs much less. This is a mix of worms of all sizes and ages. Often the largest sizes will have already been separated out for sale as fish bait. That's perfectly okay. Since hatchlings run 150,000 to the pound and mature worms count about 600-700, the population of a pound of pit run can vary greatly. A reasonable pit run estimate is 2,000 to the pound.

Actually it doesn't matter what the number is, it is their weight that determines how much they'll eat. Redworms eat slightly more than their weight in food every day. If that is so, why did I recommend first starting vermicomposting with two pounds of worms for every pound of garbage? Because the worms you'll buy will not be used to living in the kind of bedding you'll give them nor adjusted to the mix of garbage you'll feed them. Initially there may be some losses. After a few weeks the surviving worms will have adjusted.

Most people have little tolerance for outright failure. But if they have a record of successes behind them, minor glitches won't stop them. So it is vital to start with enough worms. The only time vermicomposting becomes odoriferous is when the worms are fed too much. If they quickly eat all the food that they are given the system runs remarkably smoothly and makes no offense. Please keep that in mind since there may well be some short-lived problems until you learn to gauge their intake.

### Setting Up a Worm Box

Redworms need a damp but not soggy environment with a moisture content more or less 75 percent by weight. But bedding material starts out very dry. So weigh the bedding and then add three times that weight of water. The rule to remember here is "a pint's a pound the world 'round," or one gallon of water weighs about eight pounds. As a gauge, it takes 1 to 1-1/2 pounds of dry bedding for each cubic foot of box.

Preparing bedding material can be a messy job. The best container is probably an empty garbage can, though in a pinch it can be done in a kitchen sink or a couple of five gallon plastic buckets. Cautiously put half the (probably dusty) bedding in the mixing container. Add about one-half the needed water and mix thoroughly. Then add two handfuls of soil, the rest of the bedding, and the balance of the water. Continue mixing until all the water has been absorbed. Then spread the material evenly through your empty worm box. If you've measured correctly no water should leak out the bottom vent holes and the bedding should not drip when a handful is squeezed moderately hard.

Then add the worms. Spread your redworms over the surface of the bedding. They'll burrow under the surface to avoid the light and in a few minutes will be gone. Then add garbage. When you do this the first time, I suggest that you spread the garbage over the entire surface and mix it in using a three-tined hand cultivator. This is the best tool to work the box with because the rounded points won't cut worms.

Then cover the box. Mary Applehof suggests using a black plastic sheet slightly smaller than the inside dimensions of the container. Black material keeps out light and allows the worms to be active right on the surface. You may find that a plastic covering retains too much moisture and overly restricts air flow. When I covered my worm box with plastic it dripped too much. But then, most of what I feed the worms is fresh vegetable material that runs 80-90 percent water. Other households may feed dryer material like stale bread [not good for the worms] and leftovers. I've found that on our diet it is better to keep the box in a dimly lit place and to use a single sheet of newspaper folded to the inside dimensions of the box as a loose cover that encourages aeration, somewhat reduces light on the surface, and lessens moisture loss yet does not completely stop it.

### Feeding the Worms

Redworms will thrive on any kind of vegetable waste you create while preparing food. Here's a partial list to consider: potato peelings, citrus rinds, the outer leaves of lettuce and cabbage, spinach stems, cabbage and cauliflower cores,

celery butts, plate scrapings, tea bags, egg shells, juicer pulp. The worms' absolute favorite seems to be used coffee grounds though these can ferment and make a sour smell.

Drip coffee lovers can put the filters in too. This extra paper merely supplements the bedding. Large pieces of vegetable matter can take a long time to be digested. Before tossing cabbage or cauliflower cores or celery butts into the compost bucket, cut them up into finer chunks or thin slices. It is not necessary to grind the garbage.

Putting meat products into a worm box is a mistake. The odors from decaying meat can be foul and it has been known to attract mice and rats. Small quantities cut up finely and well dispersed will digest neatly. Bones are slow to decompose in a worm box. If you spread the worm casts as compost it may not look attractive containing whitened, picked-clean bones. Chicken bones are soft and may (?) disappear during vermicomposting. If you could grind bones before sending them to the worm bin, they would make valuable additions to your compost. Avoid putting non-biodegradable items like plastic, bottle caps, rubber bands, aluminum foil, and glass into the worm box.

Do not let your cat use the worm bin as a litter box.. The odor of cat urine would soon become intolerable while the urine is so high in nitrogen that it might kill some worms. Most seriously, cat manure can transmit the cysts of a protozoan disease organism called *Toxoplasma gondii*, although most cats do not carry the disease. These parasites may also be harbored in adult humans without them feeling any ill effects. However, transmitted from mother to developing fetus, *Toxoplasma gondii* can cause brain damage. You are going to handle the contents of your worm bin and won't want to take a chance on being infected with these parasites.

Most people use some sort of plastic jar, recycled half- gallon yogurt tub, empty waxed paper milk carton, or similar thing to hold kitchen garbage. Odors develop when anaerobic decomposition begins. If the holding tub is getting high, don't cover it, feed it to the worms.

It is neater to add garbage in spots rather than mixing it throughout the bin. When feeding garbage into the worm bin, lift the cover, pull back the bedding with a three-tine hand cultivator, and make a hole about the size of your garbage container. Dump the waste into that hole and cover it with an inch or so of bedding. The whole operation only takes a few minutes. A few days later the kitchen compost bucket will again be ready. Make and fill another hole adjacent to the first. Methodically go around the box this way. By the time you get back to the first spot the garbage will have become unrecognizable, the spot will seem to contain mostly worm casts and bedding, and will not give off strongly unpleasant odors when disturbed.

## Seasonal Overloads

On festive occasions, holidays, and during canning season it is easy to overload the digestive capacity of a worm bin. The problem will correct itself without doing anything but you may not be willing to live with anaerobic odors for a week or two. One simple way to accelerate the "healing" of an anaerobic box is to fluff it up with your hand cultivator.

Vegetablearian households greatly increase the amount of organic waste they generate during summer. So do people who can or freeze when the garden is "on." One vermicomposting solution to this seasonal overload is to start up a second, summertime-only outdoor worm bin in the garage or other shaded location. Appelhof uses an old, leaky galvanized washtub for this purpose. The tub gets a few inches of fresh bedding and then is inoculated with a gallon of working vermicompost from the original bin. Extra garbage goes in all summer. Mary says:

"I have used for a "worm bin annex" an old leaky galvanized washtub, kept outside near the garage. During canning season the grape pulp, corn cobs, corn husks, bean cuttings and other fall harvest residues went into the container. It got soggy when it rained and the worms got huge from all the food and moisture. We brought it inside at about the time of the first frost. The worms kept working the material until there was no food left. After six to eight months, the only identifiable remains were a few corn cobs, squash seeds, tomato skins and some undecomposed corn husks. The rest was an excellent batch of worm castings and a very few hardy, undernourished worms."

## Vacations

Going away from home for a few weeks is not a problem. The worms will simply continue eating the garbage left in the bin. Eventually their food supply will decline enough that the population will drop. This will remedy itself as soon as you begin feeding the bin again. If a month or more is going to pass without adding food or if the house will be unheated during a winter "sabbatical," you should give your worms to a friend to care for.

## Fruit Flies

Fruit flies can, on occasion, be a very annoying problem if you keep the worm bins in your house. They will not be present all the time nor in every house at any time but when they are present they are a nuisance. Fruit flies aren't unsanitary, they don't bite or seek out people to bother. They seek out over-ripe fruit and fruit pulp. Usually, fruit flies will hover around the food source that interests them. In high summer we have accepted having a few share our kitchen along with the enormous spread of ripe and ripening tomatoes atop the kitchen counter. When we're making fresh "V-7" juice on demand throughout the day, they tend to congregate over the juicer's discharge pail that holds a mixture of vegetable pulps. If your worm bin contains these types of materials, fruit flies may find it attractive.

Appelhof suggests sucking them up with a vacuum cleaner hose if their numbers become annoying. Fruit flies are a good reason for those of Teutonic tidiness to vermicompost in the basement or outside the house if possible.

## Maintenance

After a new bin has been running for a few weeks, you'll see the bedding becoming darker and will spot individual worm casts. Even though food is steadily added, the bedding will gradually vanish. Extensive decomposition of the bedding by other small soil animals and microorganisms begins to be significant.

As worm casts become a larger proportion of the bin, conditions deteriorate for the worms. Eventually the worms suffer and their number and activity begins to drop off. Differences in bedding, temperature, moisture, and the composition of your kitchen's garbage will control how long it takes but eventually you must separate the worms from their castings and put them into fresh bedding. If you're using vermicomposting year-round, it probably will be necessary to regenerate the box about once every four months.

## Separating Worms

There are a number of methods for separating redworms from their castings. Hand sorting works well after a worm box has first been allowed to run down a bit. The worms are not fed until almost all their food has been consumed and they are living in nearly pure castings. Then lay out a thick sheet of plastic at least four feet square on the ground, floor, or on a table and dump the contents of the worm box on it.

Make six to nine cone-shaped piles. You'll see worms all over. If you're working inside, make sure there is bright light in the room. The worms will move into the center of each pile. Wait five minutes or so and then delicately scrape off the surface of each conical heap, one after another.. By the time you finish with the last pile the worms will have retreated further and you can begin with the first heap again.

You repeat this procedure, gradually scraping away casts until there is not much left of the conical heaps. In a surprisingly short time, the worms will all be squirming in the center of a small pile of castings. There is no need to completely separate the worms from all the castings. You can now gather up the worms and place them in fresh bedding to start anew without further inconvenience for another four months. Use the vermicompost on house plants, in the garden, or save it for later.

Hand sorting is particularly useful if you want to give a few pounds of redworms to a friend.

Dividing the box is another, simpler method. You simply remove about two-thirds of the box's contents and spread it on the garden. Then refill the box with fresh bedding and distribute the remaining worms, castings, and food still in the box. Plenty of worms and egg cocoons will remain to populate the box. The worms that you dumped on the garden will probably not survive there.

A better method of dividing a box prevents wasting so many worms. All of the box's contents are pushed to one side, leaving one-third to one-half of the box empty. New bedding and fresh food are put on the "new" side. No food is given to the "old" side for a month or so. By that time virtually all the worms will have migrated to the "new" side. Then the "old" side may be emptied and refilled with fresh bedding.