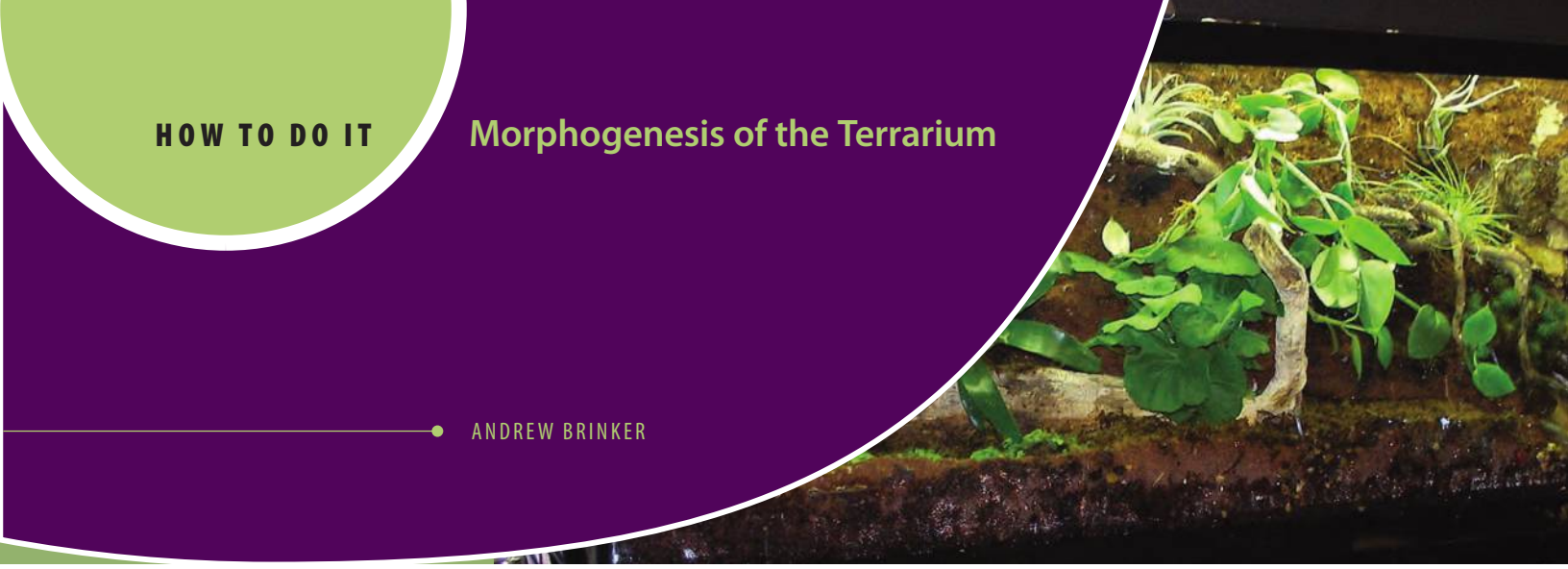
HOW TO DO IT

Morphogenesis of the Terrarium



ANDREW BRINKER

Abstract

Terrariums have decorated the shelves and counters of biology offices and classrooms for centuries. Living organisms inspire students and teachers alike. These wonderful ecosystems allow for both experimentation and observation of living systems. Here, I outline a new approach to building classroom terrariums. Historically, terrariums have been made using rocks, gravel, soil, wood, leaves, and organic props. This process often creates an immovable terrarium that weighs several hundred pounds. Although this approach will continue to produce beautiful terrariums, new technology has given us the opportunity to create more intricate terrariums that are a fraction of the weight and, therefore, mobile. The step-by-step protocol given here will allow biology professionals with little experience building terrariums an opportunity to explore this rewarding practice.

Key Words: *Terrarium; exhibit; pet; filtration; plants.*

Building terrariums is a hobby and a passion for many biologists. Niko Tinbergen's accidental discovery of the fixed action pattern of the three-spined stickleback fish is a classic example of how keeping captive organisms can lead to scientific discoveries as well as inquiries. Terrariums are works of art that can be seen in homes, schools, zoos, and museums across the globe. Traditionally, they are constructed from natural materials collected from the field, including gravel, rocks, and organic materials such as sticks, leaves, and branches. This antiquated process creates beautiful terrariums but often results in permanent fixtures that are impossible to move intact. Unfortunately, a move is almost always inevitable. A change in classrooms, new office, new exhibit, or summer vacation may require the arduous task of disassembling the behemoth of a terrarium so that it can actually be moved. Here, I explain an alternative style of building terrariums using more up-to-date technology that was pioneered by herpetarium keepers at the Fort Worth Zoo under the direction of Clay M. Garrett.

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○ Construction

The organism(s) to be housed in the terrarium, and their specific abiotic requirements, must be researched before construction begins. The example discussed here is a terrestrial dart frog (*Dendrobates tinctorius*) exhibit that recreates a chunk of forest floor adjacent to a seep.

All enclosures begin with a shell, and I recommend purchasing a water-tight glass aquarium. The dart frog terrarium was made using a 55-gallon aquarium. For the more experienced biologist, a custom exoskeleton can be constructed from glass or plastic screen purchased at a home improvement store. It is essential that the enclosure is water tight, even if there are no pools or waterfalls. Plants and animals will still need watering.

Hardware cloth is ideal for creating the basic structure of walls and planters, similar to the rebar used in concrete work or the two-by-fours used when framing a house. Hardware cloth is pliable and can be bent to create nearly any desired shape or structure. The walls of the terrarium should be wavy, giving some relief to the walls (Figure 1). Planters can be made using small sections of hardware cloth attached to walls of the same material. It is important to consider lighting when choosing locations of planters; make sure the planters are staggered to avoid shading each other. In addition to the planters on the walls of the terrarium, consider the location of the plants you will have on the floor of the terrarium.

The floor can be made using large pieces of plastic "egg-crate" light covers, which can be found at any home improvement store in the lighting section. It is very important that the egg-crate panels chosen are not solid and allow drainage. The hardware cloth and egg-crate panels can be easily cut using wire-cutters or toenail clippers. Plastic zip ties can be used to fasten pieces of either material together.

Terrestrial terrariums benefit from the use of a false bottom that allows for filtration and a water reservoir (Figure 2). This is easily accomplished by making rectangular boxes using the egg-crate panels zip-tied together (approximately 5 × 8 cm in the example below) and then placing an egg-crate panel that has been cut to the same dimensions as the aquarium floor on top of these blocks. In order to keep the substrate from falling through the large holes in the egg-crate panel, it is covered in fiberglass screen (the same material used for screen doors and windows).

With the basic structural components established, the walls and planters are covered with spray foam. This insulating spray foam costs about $7 a can and is found at home improvement stores. It is very important to shake the can well and remember that the foam is going to expand! Another fantastic property of spray foam is that it can easily be carved with a knife or razorblade after it has dried and hardened (an

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Figure 1. Hardware cloth being shaped to create a back wall. The same material can be shaped and attached to make planters.

Figure 2. Notice the false bottom created using a plastic egg-crate light cover, resting on small blocks created using the same material. The sheet is covered by fiberglass screen to allow for drainage and prevent substrate from falling into the water reservoir below.

important step in hollowing out the planters). This foam is extremely sticky, and care must be taken not to leave it on nearby furniture, clothing, or skin. The foam sets with surprising strength, allowing natural rocks and wood to be embedded (Figure 3). These natural props can be added while the terrarium is lying on its side and should not be moved until the foam has set.

The next step involves the transformation of the conspicuous white foam into a naturalistic dirt bank. Coconut bark substrate is the main component of the wall covering and can be purchased at most pet stores. Usually sold in brick form, it must be soaked in water (follow the directions on the package) and allowed to expand. The wet coconut substrate must then be spread out over a counter or on several trays and allowed

Figure 3. Notice the limestone rocks on the far right and the root coming from the middle of the back wall. The foam is surprisingly strong and can be used to hold natural props.

to dry completely, which may take a few days. The dry coconut bark is applied using silicone sealant, sold in the plumbing section of home improvement stores. It is available in many colors; be sure to purchase either black or brown so that any areas exposed over the years are not the white color of the foam. Do not try to cover all of the spray foam in a single setting; it is best to finish small sections daily. A 10-gallon tank may take only two 1-hour sessions, but a 55-gallon tank (below) may take five or six applications. Creating a beautiful terrarium takes weeks; don't rush it. Apply the silicone using rubber gloves, completely covering all of the spray foam in the area being worked on. After liberally applying silicone to an area of the foam, take handfuls of the coconut substrate and gently press it into the silicone. After the section is completely covered in silicone and coconut substrate, it must be allowed to dry for 24 hours.

○ Substrate

The substrate is essential for the proper functioning of a terrarium, especially nutrient cycling. Proper drainage is a step often overlooked by novices. In planters and across any flat areas that will contain plants, begin with a thin layer of pea gravel (1–2 cm for a 30–55 gallon aquarium) and increase the depth of this layer as the size of the terrarium increases. Before putting the pea gravel in the terrarium, it should be washed to prevent the build-up of sediment in the water reservoir. Gravel is easily washed using a small bucket (3–6 L) and hose or faucet. The gravel is rinsed while churning it with your hands and pouring out the dirty water. Once the water in the bucket is clear, the gravel is ready to be put in the terrarium. Above the pea gravel, place a thin layer of cypress mulch (this will help keep the soil mixture from infiltrating the gravel). Above the cypress mulch is a layer of soil. I recommend a mixture of 25% sphagnum moss, 25% coconut bark, and 50% loam soil. The sphagnum moss is an important source of acidity, and its percentage can be adjusted depending on the preferred acidity of the plants and animals.

○ Lid

The lid can be made from glass and egg-crate panel wrapped in fiberglass screen. To keep humidity levels high, 80% of the top is covered

Figure 4. The lid was created using a piece of glass and the plastic egg-crate light cover with fiberglass screen. A handle can be attached using silicone.

with glass and the remaining 20% with the egg-crate panel covered in fiberglass screen for good air flow (Figure 4). Most home improvement stores will cut to custom dimensions for a snug fit. A small handle can be fastened to the glass using silicone, which allows easy access when feeding captives and watering plants.

○ Introducing Plants & Animals

Now that the hard work is over, it is time to introduce living organisms. By utilizing the planters and available floor space, even a 20-gallon terrarium can easily house a dozen species of plants. Epiphytes are a great choice because they don't require soil. Air plants are epiphytes that grow on trees, rocks, and dead branches and receive all their nutrients from the atmosphere through openings called "trichomes." These plants are only a few dollars apiece and can be purchased online. Another advantage to this group of plants is how easily they can be attached to the foam walls using large staples (push them in, don't use the staple gun!). Bromeliads are also a nice addition to terrestrial aquariums, as they offer an aquatic refuge appreciated by many animals. Occasional pruning helps prevent the loss of diversity through a single species outcompeting the others. After adding plants, animals can be introduced. When choosing which species to place in the terrarium, try to pick diurnal species that lend themselves to easy observations. Poison dart frogs are a great taxon to consider, as they are active throughout the day and can be fed fruit flies, which are easily cultured in the classroom. Although this group of frogs can be extremely toxic, they sequester their toxins from their food items and are harmless in captivity (Figure 5).

○ Water Features

Water features not only create a more attractive terrarium but help maintain water quality and humidity and may be needed for reproduction of captives. Streams, pools, and waterfalls can be readily made using hardware cloth and foam. Hoses for moving water can be foamed into place. The frog terrarium example has two water features, although they are difficult to see in the photo. There is a stream that begins in the back left and continues to the pool on the bottom right of the tank. The line feeding the stream was divided, and a second hose supplies a cascading waterfall on the right-hand side of the tank that fills the same shallow pool the stream empties into. A canister filter can be used to power these simple water features, and cleaning these filters once weekly ensures high water quality. The return hose for the filter can be fed through the back corner of the lid to the water reservoir (Figure 4).

Figure 5. The finished dart frog terrarium. Notice the frog sitting on the log at left.

○ Conclusion

The technique outlined above not only produces beautiful terrariums, but more mobile ones that are a fraction of the weight of traditional terrariums. Water quality is always a concern when using synthetic products in animal enclosures. Although I was unable to find any information on the leaching of these materials, I have seen no evidence of contamination while keeping amphibians in similar enclosures for more than 8 years; in fact, amphibian reproduction has occurred several times over the past 8 years in exhibits made with the same materials. One exhibit created for a rare newt species at the zoo actually helped induce breeding (a first-time breeding for the Fort Worth Zoo). The longevity of these materials has also proved to be exceptional: after 5 years, my dart frog terrarium looks as good as the day it was made!

○ Materials List

Available at home improvement stores:

- Silicone sealant
- Pea gravel
- Cypress mulch
- Sphagnum moss
- Soil
- Glass
- Plastic egg-crate light cover
- Fiberglass screen

Available at pet stores

- Coconut bark substrate
- Aquariums
- Starter fly cultures

Available online

- Air plants
- Fruit fly medium

ANDREW BRINKER is an AP Biology and AP Environmental Science teacher at R.L. Paschal High School, Fort Worth, TX 76110. E-mail: andrew.brinker@fwisd.org.