

Creating natural environments

Mastering 3D Graphics ~ issue #1

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Natural environments are one of the most challenging scenes to create in 3D. It's not due to their complexity but actually the nature of their complexity (no pun intended). Nature is entirely organic so there are no linear lines and flat edges, well not many anyway. This makes the task of modeling and surfacing natural object significantly more complicated than industrial objects.



Of course, an industrial scene is actually far more complex to recreate than natural worlds. Industrial scenes are littered with chaos. There are countless small details on the streets, such as fire hydrants, chain link fences, dumpsters, cigarette butts, bottle caps, and the weeds that grow in the pavement cracks. This type of chaos doesn't exist in nature. Yes, there are plenty of plants, rocks, and trees in nature but when you think about it that's really all there is. We don't see the aging and corrosion of industrial worlds, nor do we see the litter, well we shouldn't.

Instead we have organic chaos and plenty of it. Natural worlds are filled with plant life, which makes them challenging to recreate. You see we can get away with a scene looking relatively planned in an industrial world because everything is manufactured, but in nature nothing can appear planned or the image will be unrealistic. Therefore, to create photorealistic natural worlds we have to utilize complete chaos to ensure it doesn't look manufactured. This means we have to be very detailed in our staging and surfacing. Of course, we still need to apply some order to natural worlds to make them appear natural. While nature is chaotic, it's also ordered. Yes, it's a tricky line we walk when creating natural worlds but it's primarily all about observation.

Natural worlds are very detailed but their details are really limited to plants, trees, and rocks. Of course, there is

also the dirt and water, but when you think about it nature is really just a whole lot of a few objects. A forest is littered with trees. While there may be several types of trees, it's the volume that creates the chaos. Of course, the trees in a forest represent the buildings of an industrial scene. They support the scene but they really don't carry the weight of the chaos and detail. It's the details on the ground level that create the chaos of natural settings, much the way it's the details of the city streets that make an industrial scene realistic. The weeds, rocks, twigs, and leaves of nature replace the garbage and clutter we see on city streets. The tree stumps replace the fire hydrants and the bushes replace the postal boxes and newspaper stands. Of course, natural scenes are much more cluttered than industry. We typically don't see city streets covered in trash, at least not in most cities. While the actual clutter details of city streets are more detailed, the volume of clutter in nature is much greater, making natural environments very resource abusive.

While a natural environment presents challenges due to the volume of organic details, the wilderness doesn't have an abundance of surfaces to get dirty and worn. We're not going to see a lot of grease, grime, rust, and oil in nature. Nor will we see a great deal of garbage. Well, hopefully we won't. Natural worlds are usually relatively clean. While they are covered in dirt, they don't have rusty, corroded, and grungy surfaces. We don't see bushes

covered in dirt stains. The leaves may be dusty but they aren't covered in grime. Of course, there are some places in nature that are quite grimy, such as swamps and bogs, which are covered in fungus and other sticky things we prefer not to experience, but these are usually isolated cases. For the most part nature is free of grunge.

The first step in creating natural worlds is to observe the wilderness around us. We need to identify the key details that make a natural world believable. There are certain details that will make the natural scenes we create appear startlingly realistic. It's really all about attention to detail and observation. I recommend before you begin to create your natural worlds you explore the wilderness around you and take plenty of pictures. Of course, if you live in the city and don't have access to natural settings I suggest you spend a great deal of time watching the Nature Channel on television or visiting the local library or parks. If we try to recreate natural settings from memory we're going to miss those critical little details that make the scene undeniably realistic. We really need to immerse ourselves in the environment to capture the small details such as pebbles, ground covers, and twigs.

To get a better idea of the details we need to concentrate on when developing photorealistic natural worlds, let's

take a look at an image of a natural 3D setting. [Figure 1.1](#) shows an example of a complex natural environment.

Here we have a shot of the Unfathomable Crag from the Great Goblin Gauntlet. Grumpy, the lead character of Goblin lore, is seen on a hunt for Shiny Things. Shiny Things are the currency of Goblins. Anything shiny has



Figure 1.1: A photorealistic natural setting.

significant value, particularly metals, gems, and ores. This particular scene shows the fringe of the Rain Forest where it meets the Enchanted Desert. The Unfathomable Crag is a major icon in Goblin legend.

It's rumored that a young boy and girl Goblin were running through the forest when they fell into the crag. Goblins are very resilient characters so they didn't die in the fall, but the crag is miles deep and they can't climb out. They were forced to live out their lives in caves deep below the Earth's crust. Well, the Goblin sweethearts eventually had children and their community grew larger with each generation. There is now a whole community of Crag Dweller that is said to feed upon the unfortunate Goblins who fall in the Crag. It's told you can hear the screams of the Crag Goblins at night, which are meant to lure unsuspecting Goblins closer to the Crag so they will fall in and feed the savage Crag Goblins.

Of course, the legend is only partially true. Yes, the sweetheart Goblins did fall in the Crag and they eventually expanded their family, but they don't eat the Goblins that fall into the crag. The new Goblins simply join the other unfortunate Goblins who feed upon insects and crawfish from a fresh water spring. It's actually quite nice in the Crag, a bit dark but generally a pleasant place. The screams heard at night are actually sounds of celebration

coming from the Goblins partying in the Crag. Of course, the Crag Goblins don't want this to be known because there would be hordes of Goblins leaping into the Crag to join the party and there just isn't that much space, so they let the legend continue.

As you can see, the environment looks very realistic. It's riddled with the detail and chaos we expect to see in a

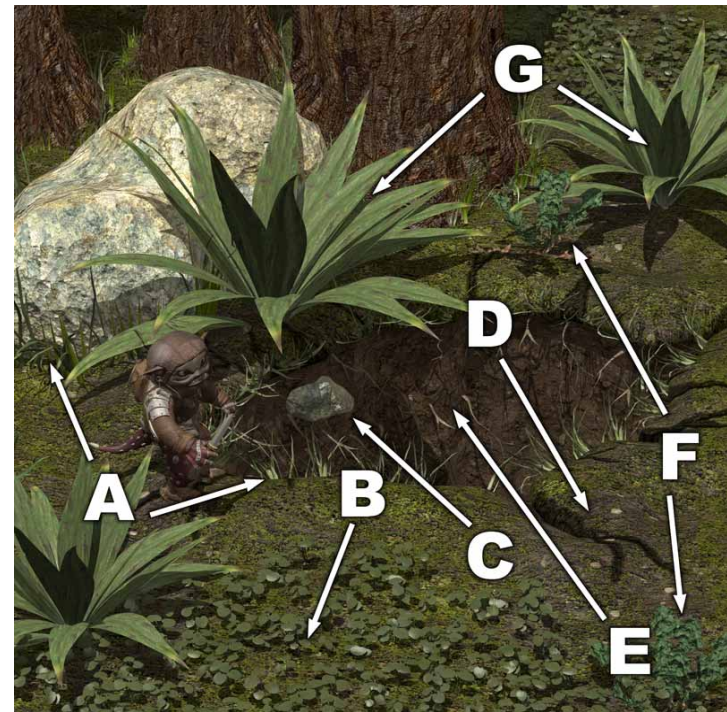


Figure 1.2: A closer look at the details.

natural world. We have random trees, scattered bushes and weeds, a chaotic ground cover, and dirt littered with rocks and twigs. It's actually a very detailed scene, yet there are really only a few types of objects in the scene. We have a tree, rock, clover ground cover, Guzloader (a prehistoric plant) plant, and dirt. If this were a city street scene we would have far too few objects to make it appear realistic, but as a natural scene we have plenty of objects. The key is to have several of each object in the scene. In fact, let's take a closer look at the details to get a better idea of their importance. Take a look at the callouts in [Figure 1.2](#).

A. Fringe Grass.

One of the most common elements we see in natural settings is grass growing around the fringe of permanent objects. This is a very simple element to create, which we will be doing later in the chapter, but it adds a tremendous amount of chaos and detail to the scene. The simple grass has been wrapped around the rock, trees, and even the Crag to make the image appear more natural and chaotic. Grass is one of the most important tools for creating natural realities. It's the most common element in natural settings. It comes in a wide variety of visual forms and is extremely simple to create.

B. Ground cover.

Ground cover is a staple in most natural settings. While it may not always be thick and abundant, there is most certainly some form of ground cover. It's a necessity for survival of surrounding plants. A ground cover traps the moisture of the soil so it won't evaporate, thereby retaining the precious water needed by the surrounding plants. About the only place where you won't find a ground cover is a desert and even they have ground covers, just very stark ones since the soil is very dry. The ground cover in this image is a perfect example of how Nature creates her ground covers. Notice how it's not an even coverage. The clover has dense and barren spots randomly thorough the image. This is important for making the ground cover believable. Let's face it, ground covers are only consistently dense in industrial worlds. The grass covering our front yards and parks is very dense because we engineered it that way. A grassy field in reality is very thin and not evenly distributed. The wind isn't terribly particular about where it blows the seeds. If you want to create convincing ground covers they need to have spots where the density varies dramatically.

In addition to random density of ground covers you should also add plenty of random chaos to the size

and rotation of the ground cover details. The clover in this image was made chaotic by applying a fractal noise displacement. You should always add chaos to your ground covers so they don't look too perfect.

C. Random Rocks.

Nature is full of random rocks. There are perfect elements to accent your natural settings because they are easy to create in abundance. They are also easy to surface because they don't have too many specific details. Now, typically a rock like the one illustrated would be dirty from being buried in dirt but this rock is clean because it's exposed to the natural elements such as rain and wind. It's been washed clean over the years by the elements and will eventually fall below when the dirt is eroded away. Of course, this is likely to reduce the Goblin population below when it hits one of them on the head.

D. Bare Spots.

While the ground is covered in a short moss, it has numerous bare spots, which are critical for photorealism. Nothing grown with consistency in nature. There will always be dense and light spots for ground covers or any other plant life, such as trees. There will always be a clearing in a forest since trees

cannot grow with an even distribution in nature. In this example image the moss texture is random, covering much of the ground but exposing random areas to make it more natural. To reinforce the natural chaos, small pebbles have been added to the bare spots to break up the dirt texture. We can assume there will be some pebbles visible in the bare areas where the dirt has eroded away from exposure to the elements.

E. Roots.

Roots aren't a staple of most natural settings but they do add some nice detail and are fairly simple to create. While your scenes may not have a crag in them, you should experiment with placing surface roots in the scene to add some chaos.

F. Random Weeds.

Nature is littered with random weeds, they are seen in every natural setting on the planet. Your natural settings should always include an abundance of weeds. You should also provide a variety of weeds in your natural worlds. The example image is a very tight shot with a major hole in the middle so it doesn't have but one type of weed, a dandelion. If there were more surface area it would likely have a variety of weeds, including ragweed, foxweed and crabgrass.

G. Plant Placement.

The placement of plants is critical in a natural setting. While the placement in our gardens and parks has nothing to do with the available water, Nature on the other hand plants her major growth near the water supply. Plants need plenty of water so they will grow where the supply is most abundant. While this doesn't mean they only grow near bodies of water, it does mean they will need to grow in fertile soil, which means the soil needs to retain moisture. Plants in nature will grow near permanent objects and ground covers where the soil is rich with moisture. In this image the Guzloader plants are growing near the clover ground cover and the rock, which both help retain moisture in the soil.

As you can see, there really aren't too many details to photorealistic natural settings, there is just a large abundance of a few details. It's really all about where they are placed and their volume of distribution. If you want your natural settings to appear photorealistic you need to provide a few simple elements, a randomly dense ground cover, random weeds, and the occasional rock and twig. The formula is really that simple. The key is to provide a good variety of weeds and chaos, and if possible a number of different ground covers of varied height. The image in Figure 1.2 has two different ground covers, moss and clover. The moss is a very low bump mapped ground

cover while the clover is a higher, physical mesh ground cover. The combination of these two ground covers fills out the scene nicely. You don't want a great deal of dirt showing unless you are creating a desert like the one shown in [Figure 1.3](#).

Here we have a shot of the Enchanted Goblin Desert after a Goblin has walked through it and dropped a bead



Figure 1.3: The sparse ground cover of a desert.

of sweat on the ground. The dirt in the desert is enchanted by the bones of the Great Mystics who came to Earth in hopes of finding intelligent life to propagate their dying race. Of course, all they found was a civilization of dinosaurs and goofy Goblins. After thousands of years one of the Mystics died, so the other Mystics buried him on the Goblin Island. The Mystics had great powers and their bones are very magical. When the bones are placed in the dirt, they enchant the dirt for miles. Since the Goblin Island is only 20 miles across, nearly half the island is enchanted by the Mystic's bones, which has brought many inanimate objects to life, including mushrooms, stones, and even tubers, all of which can be seen in the color insert of this book.

Well, when water is dropped on the Enchanted Desert it animates the dirt, creating Mud Goblins. These Mud Goblins are quite loud and obnoxious. The normal Goblins hate them because they are far too friendly, running around saying hello to everyone in sight. The Mud Goblins only live as long as they have moisture to keep the dirt wet so when they are created they make a mad dash for the bordering rain forest. Of course, they rarely make it because they usually run in the wrong direction. The desert floor is littered with mounds of dirt that were former Mud Goblins. While they don't look like much from ground

level they resemble mud corpses strewn about on a battlefield from the air.

It takes quite a bit of dirt to create a Mud Goblin, typically several gallons. So what happens when only a bead of sweat hits the desert dirt? It creates a Desert Wart, which is a tiny Goblin like the one seen in Figure 8.4. It's basi-



Figure 1.4: Dense ground cover of a forest.

cally just a bump on the desert floor that is only a quarter inch in diameter. When it sprinkles rain in the desert thousands of these little guys are created, which can be very annoying since they are quite loud. The rule of thumb is don't, at any cost, drop any water on the desert floor. It's a punishable crime in the Goblin kingdom.

Take a close look at Figure 9.3 and you'll notice the ground is clearly visible with a light dispersion of grass and the occasional weed. There isn't much precipitation in the desert so it's very barren. On the other hand, a forest holds a great deal of moisture so you want the ground to be thick with ground cover and weeds as shown in [Figure 1.4](#).

Before you start developing your environment be sure to consider the amount of rainfall and the general climate of your world. These factors determine the density of foliage we can expect to see in the scene. A rain forest has tremendous rainfall so it's very thick with botany, while a desert has very little rainfall so it's barren with only the occasional plant, and it's typically dead. If you use the rainfall as the basis for the density of botany you can't go wrong.

Wrap Up

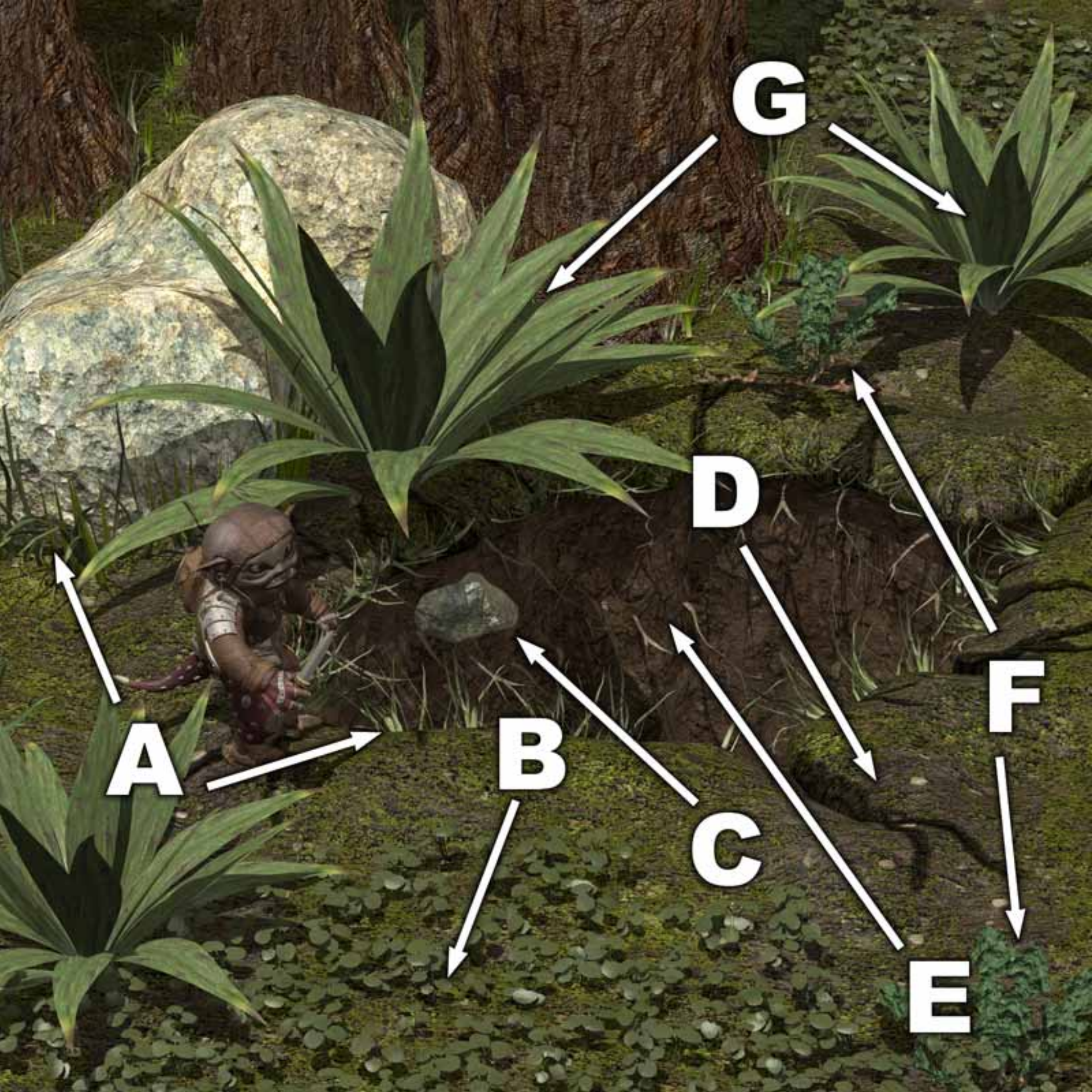
The key to successfully creating organic worlds is to focus on the small details. It's all about observation. It's a matter of exploring the natural world and mimicking the

details you see. Besides, a walk in the wilderness can be a nice break from getting your eyes fried by monitor radiation. Before you begin to create your 3D natural worlds you should spend plenty of time exploring the natural environments around you to get a feel for the details you should include. Don't forget to bring your camera, something to sketch small details and be sure to make a list of the small elements you see. Don't be in such a hurry that you overlook that little mushroom peeking out from under a leaf or those random twigs under the canopy of a pine tree. Remember the more detail you add the more realistic the image becomes.

The contents of this article were extracted from Bill Fleming's "Advanced 3D Photorealism", the sequel to the international bestseller 3D Photorealism Toolkit, which covers many of Bill's never before revealed techniques for creating realistic digital botany. Advanced 3D Photorealism is published by John Wiley & Sons, and ships in August 1999.

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