

A Magical Society: Ecology and Culture



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To members of the Council and those who audience these pages,

This treatise presents a collection of ideas, conditions, and advice on world building for others who follow me, may they glean insight from my experiences. I have chosen this path of recording over more extraordinary methods in hopes that, should I complete the task satisfactorily, it may act as a guide for godlings that follow.

Split into three distinct but related parts, the unifying theme of this work is mapping a new world. Book the first concerns the rudimentary decisions in world building and their implications, including but not limited to the manner in which landforms appear, why they appear in that fashion, and advice on creating maps based upon sound physical geography. Book the second concerns ecologies, various biomes and environments created by the interaction of weather and physical geography, the creatures occupying these various environments, and advice on mapping these places. Book the third concerns the limitations environment places on intelligent races, tools of culture that intelligent races use to overcome their environment, and advice on mapping cultures. Following these three sections is a collection of useful reference appendices.

The base world for comparison and reference is Earth, which functions without major magical intercession. All discussed deviations are from the perspective of Earth-like worlds, and numerous examples are drawn from Earth. In this work, magic – a complex factor in world creation—is treated as another source of accessible energy. Like sunlight and geothermal energy, magic is a building block for life and links the traditional features of many fantastic worlds to the intricate mundane web of life: vast underground populations; amazingly lush, fertile, and inexhaustible environments; and a plethora of massive predators whose existence must be magical.

Some argue that gods create worlds. Period. Others point out that gods may be living in a closed system created by a greater force, as godlings' creations are no more real except to those living in the creation. Regardless of how things are made, our primary goal is proper functioning. Things must work on their own without the constant intercession of their creators, other gods, and their magic. That being said, gods still interfere; however in the best of worlds, it is minimally necessary. With all these considerations, I humbly submit my observances for your enjoyment, scrutiny, and perusal.

Kierian the Bold
Petitioner for God of War and Bringer of Justice

Satisfactory
*See back for comments

Interlude

Kierian moaned at the first tinges of consciousness. He opened his eyes and rubbed the sleep from them. As his senses awakened, he noted the strangeness of his surroundings. The air was stiff like a skin pulled over a drum—still, yet stretched with taut energy. The light was neither dim nor luminescent, but it glowed vibrantly. The room was hardly a room, absent of walls, ceiling, and floor. Then there was the gnome sitting ten feet away from him, reclining with a pipe and making scribbles in a little pocket book. Looking up from his writings, he smiled warmly.



"You're up then," Noj spoke matter-of-factly as he closed his book. "Good. We have lots of work to do."

"Where am I?" Kierian asked in confusion. "And who are you?" He placed an anxious hand on the hilt of his blade.

The fastidious gnome's smile faded. "You don't know?"

Kierian rose to his full height, surveying his surroundings. "No. This place is not known to me."

"Oh dear." Noj sat down again and motioned for Kierian to take a seat. To Kierian's surprise, there was a chair for him where there had not been before.

"What sorcery is this?" Kierian drew his sword and looked around. He sensed a change in his blade. The sword was different in his grasp, lighter and weightier at the same time.

Noj looked up muttering Gnomish curses. "Please, just sit down, and we'll straighten this out." He opened his brown plaid waistcoat to reveal his possessions, of which were no weapons or devices of sorcery. "As you can see, there is little need for your sword."



Kierian cautiously took a seat but refused to sheath his sword, resting it beside his leg. The gnome flipped to an earmarked page and produced a pencil from his breast pocket. "Are you Kierian of Rockmoor?"

"Yes," answered the surprised fighter.

Noj looked up and nodded in confirmation. He moved the tip of his pencil down the page. "And you slew Korgol the Destroyer, God of War, Bringer of Chaos, Widow Maker, Devourer of Souls, etc?"

Flashes of memory sparked a recollection. There was a battle, a victory, then lightening; it wasn't natural, but powerful. "Yes. I suppose I did," conceded Kierian.

Noj closed his book with a reaffirming smile. "Then there is no mistake. You are Kierian of Rockmoor, God of War, Bringer of Justice." The satisfied gnome noted Kierian's blank expression. "Don't worry. Everyone starts out with a short title. You'll get more as time goes on, though most gods would abandon 'of Rockmoor' for something less... common."

Kierian stood, pacing back and forth for a few moments. "So let me get this straight." Kierian's precise steps echoed crisply in the emptiness. "I kill a god, and I take his place. Easy as that?"

"Yes and no," Noj replied with a hint of scholasticism. "The position is temporarily empty, and a period of chaos will reign until the new God of War asserts him or herself. Since you killed the last God of War, you have precedence to fill the position, provided you prove ready."

Kierian's brow furrowed, and he took his seat again. Pacing on a non-existent floor unsettled him while the lingering traces of mortal suspicion and doubt interfered with his divine intelligence. "Ready?"

"Yes. There is the small matter of the task." Noj relit his pipe, realizing this was going to take a while.

Kierian leaned toward the gnome. "What's 'The Task'?"

"The trial of the gods where you must prove able to wield your divinity."

Kierian loosed his sword from its sheath. Shining in the eerie glow of this place, the godling decided to call it the Blade of Righteousness. "Bring whatever foe or beast the gods dare pit against me."

Noj shook his head and stifled his laughter. "No, nothing of that sort. You killed Korgol the Destroyer, Spiller of Blood, Foe of Peace, Friend of Death, etc. That alone proves your prowess, regardless through might, wisdom, or trickery. Now you must prove your understanding."

Kierian was well over six feet tall, seventeen stone, encased in gleaming metal armor, and bore the Blade of Righteousness. This was all the understanding he had ever needed. "What must I do?" he asked in a dubious tone.

Noj answered plainly, "You must create a world."

Kierian roared, releasing peels of laughter in the expansive space. "You really had me going for a moment. 'You are the new God of War.' That's great. Who put you up to this? Was it Cora? 'Cause I didn't mean to leave her in the pit trap. I just got sidetracked on the way for help, and by the time I got back, she was already in town."

"Why do I get the difficult ones?" Noj thought to himself. "Suit yourself. Create something. Think of something, and shape it in your mind. You can give it smells and texture and taste. Go ahead." The terse edge in the gnome's tone and the imperious wave of his hand did not escape Kierian's notice. He closed his eyes and began creating. It was quiet and still. Then the smell of meat pie filled the air. Kierian opened his eyes to a golden-brown meat pie whose juices were bubbling through the buttery crust along side a frothing mug of ale.

"Did I do that?" Kierian asked incredulously.

"It wasn't me," answered Noj. "I'm a vegetarian." Kierian crept forward and held the warm pie in his hands. "It's not real, you know," injected the gnome. "Nothing created here is, except for those living within the creation itself."

The famished warrior bit into the pie. It felt like he hadn't eaten in ages. Warm juice and ale dribbled down his chin as he washed it down with a deep drink. It was the best tasting meat pie and ale he had ever eaten, but something was strange. It was a bit off. No, it was entirely wrong. "Where are we?" Kierian asked with a new intensity.

Noj straightened upon hearing the Voice of Divine manifest in the fighter's tone. "The testing ground. It's where godlings practice creating and test their theories on world building."

"And who are you?" Kierian's mind focused into a singularity. The food vanished like a memory.

The gnome stood and bowed to his new lord. "Noj Danask, well versed in the knowledge and engineering of building worlds. I am here to assist you. I put into motion that which you desire for your world. You will record your findings, and should the Council approve your process, you will come into your full divinity."

"And if I refuse?" Kierian's serious demeanor gave him a ferocity that Noj hadn't seen as of yet.

"Then you are neither here nor there, neither mortal nor god, shunned from enjoying the innocence of one and the power of the other."

They sat in silence together until Kierian rose and cleared his throat. "Right then. Where do we start?"

Noj opened his book. "At the beginning."

Mapping Your World

Maps are home to the stuff of legends and nightmares: Atlantis, Xanadu, terra incognita, "Here there be dragons!" A wise gnome once said, "A good map is almost a history." Maps show the past: treasure maps, maps of dead empires, and maps of sunken ancient lands. Maps show the present possibilities: harsh deserts, fertile meandering rivers, steamy jungles, and barrier mountains populated by fiercely independent people. Maps also show the future, for well I know that every conquer looks towards a map and dreams of empire. Maps may represent a world clearly like the finest prose or as cryptically as the best of poetry. It is because of this that I have chosen to use maps in creating my world.

Though maps of pen and paper do not require much in divine power, they are not so easily made. Most are unaware of all the landforms and physical geography worlds demand. Where to place mountains, rivers, swamps and deserts are important questions that must be answered, even for worlds which deviate from our given base planet, Earth. The more a world mimics the basic forces of nature, the more engrossing the world becomes for those living in the creation. The goal then becomes a map of the world that can run itself without magic, for if we create such a world, any magic we do implement simply adds to its charm.

Originally I found building a planet that requires as little magic as possible an odd request, especially considering my new abilities. Now I know it a valuable lesson. Once we godlings know how a mostly non-magical planet works, we can step away from the basic design into more complex and fulfilling ones. Bears, tigers, and even dinosaurs may be interesting, but they all pale in comparison to the complexity of a fully functioning magical world inhabited by orcs, ankheg, and dragons.

Beginning Considerations

It's tempting to run into world creation before thinking about the world as a whole, hastily plopping down mountains, rivers, deserts, and jungles. When enthusiasm gets the best of patience, however, godlings end up with ragtag worlds whose geography and biomes make no sense and must be supported by magic. Although magic is an important part of every world, magic shouldn't be used to explain how a river flows over a mountain, except in very special circumstances. Magical geography should be used to intensify experiences, not explain everyday phenomenon. Remember godling, the initial magic allowance for building first worlds is slim; maximize your potential by minimizing your mistakes. Such mindful consideration may one day lead to building whole planes created entirely through magic. But as of yet, that is the future.

One of the best ways to minimize mistakes is through observation. Any artist will tell you that seeing the world properly is the first step in creation. Before making maps, spend some time with a good world atlas; it contains everything we need to know about making independent, viable worlds and realistic maps. Hopefully the remainder of this tome expands your knowledge base, allowing you a new sight in how the world works through an atlas. For example, consider continents. Though we have all been taught seven traditional continents, this artificial division impedes accurate physical vision. There are really only four giant landmasses on Earth, along with several smaller islands. Of these four giant landmasses, two of them have very small isthmuses separating them roughly in half.

In this quest for proper vision, every step of the mapping process should involve some visual aid, even if you are planning a deviant, themed world, such as an archipelago world. You will benefit from time spent looking at Earth. Accurate vision prevents jarring inaccuracies and makes new worlds require less magic. If you're of



the scholarly bent or find your gnome to be lacking in forthrightness, find an ancient tome concerning geology or physical geography. Look for one in the library. There are several available, and they will cover the processes of creation to minute details. Sometimes details are exactly what you want. Please read through this whole section before beginning your map. It will help you create a better world.

Step One: The Big Picture The Heavenly Spheres

Before starting a new world map, a creator must make decisions about what the world looks like and how it interacts with the matter outside of its atmosphere. Is the universe just like the base material one, but with more or less magic? Is the new planet the center of the solar system? Do crystal spheres hold everything in their unchanging order, or do the gods move the planets and sun? Perhaps the world rides along on the back of a giant turtle? These types of questions and their answers are part of the fun in creating new worlds.

Ironically, it is here that we have the most flexibility with new worlds. The same intelligent creatures that don't like rivers flowing uphill have no problems accepting a world surrounded by crystal spheres that move the celestial bodies across the sky while intersecting the many planes. Magic on a massive, universal scale is more easily accepted than on a small scale because creatures don't interact with astrophysics as much as they interact with gravity. Sometimes the big miracle is the most believable.

Dealing with the various cosmological and world-shaping possibilities is beyond the scope of this treatise. Flat worlds, water worlds, and hollow worlds all have their place in the metaverse, but their unique patterns require serious dedication to their exploration and power beyond what godlings possess. Our focus is on Earth-like worlds, but that's far from limited. Even on the strangest prime material planes, standard types of weather and erosion usually play their part upon landmasses, just like they do on Earth. It's just the way the multiverse likes to work.

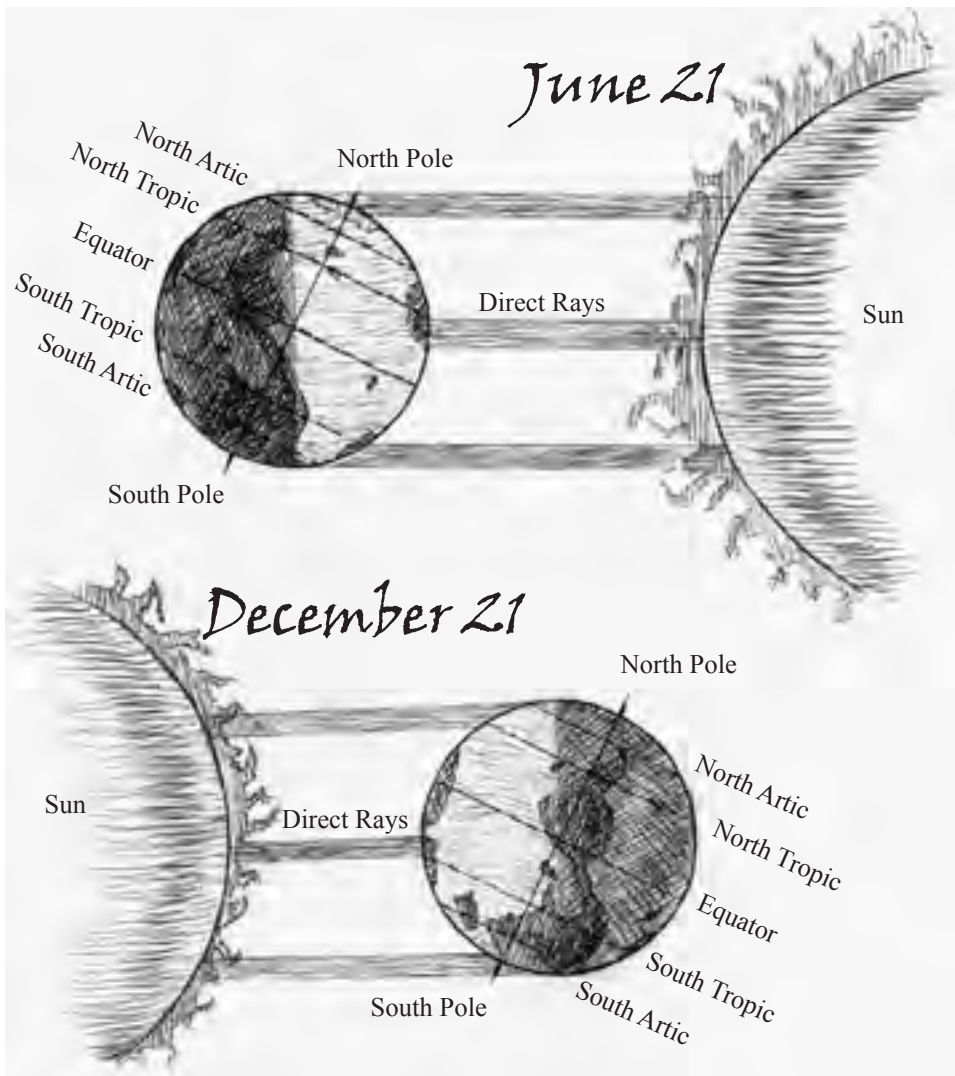
Axial Tilt and Seasons

Earth sits slightly tilted at 23.5° and rotates around this axis every 24 hours, forming a day. It also revolves around the sun every 365.25 days, forming a year. These three simple things—axial tilt, length of a day, and length of a year—are some of the most important aspects of any new world. They will have the greatest effect upon what a new world looks like.

Planets maintain their axial tilt and rotation, regardless of where they are in their annual cycle. A planet's rotation around its axis creates day and night, shifting exposure to the sun's rays in its rotation. Axial tilt determines seasons with winter occurring when the planet is tilted away from the sun and summer when the planet is tilted toward the sun. When one hemisphere is tilted away from the sun, the other is tilted toward the sun, meaning that while it's winter in one hemisphere, it's summer in the other. Axial tilt also influences the length of day and night through the creation of seasons. The amount of time the hemisphere is subject to the sun's rays determines the number of daylight hours. During the winter, the days are short, and the nights long, while during summer the reverse is true.

You can create a grid by identifying the points on the top and bottom of the planet around which the planet rotates, known as the poles. This grid allows you to pinpoint any specific location in relation to the poles, which are fixed points. Latitude is the distance measured north and south of the equator, with the equator at 0° and the poles at 90° . On Earth (or any planet 8,000 miles in diameter), each degree of latitude is roughly 69 miles, which varies due to polar flattening, but only by about 0.5 a mile. Since axial tilt provides us both with seasons and a way of locating specific places on a





planet, it also provides us a useful way of measuring daylight times. Using latitude in conjunction with axial tilt conveys a lot of information about a planet's daylight hours and climate.

Axial tilt determines the lower and upper limit of daylight on your planet. The lower limit of daylight is the place that experiences at least one complete day of darkness and one complete day of light a year. On Earth, this takes place at 66.5° latitude, which also correlates with the arctic regions of the planet (66.5° - 90°). As you travel closer to the poles, you experience more days of continuous light and continuous dark. Around the poles, day or night can last weeks. The upper limit of daylight is the place where the sun is directly overhead for at least one day of the year. On Earth, this takes place at 23.5° latitude, exactly 23.5° from the equator, which correlates with the tropical zones (0° - 23.5°). As you approach the equator, you experience more days with the sun directly overhead.

Notes on Deviant Axial Tilts

When you chose the axial tilt of a new planet, you are also determining the location of the arctic circles and the tropics, which influence basic climate. For planets to be Earth-like, axial tilts must be close to Earth's range (15° - 32°), depending on how much seasonal variation a godling wants. The greater the axial tilt, the more seasonal





variation. Keep in mind that a lot of the temperate climates rely upon snowmelt for much of their water. A smaller axial tilt may result in more widely spread deserts than on our base planet because not enough snow melts. On the other hand, too much tilt could result in more widely spread deserts because not enough snow falls.

Deviations in the axial tilt also change the distribution of surface heat on the planet: the larger the tilt, the more even the distribution of heat. With a tilt of 23.5° , Earth's heat is more evenly spread than if its tilt was 15° . To build a planet where heat is evenly distributed over the surface, a tilt of around 54° is required. This extreme tilt, however, would lead to a world very different than Earth. But there are also methods of changing climate without choosing a drastic axial tilt and all the implications that result from such a decision. For example, if you want a colder planet, perhaps your world has a larger orbit around the sun. Of your planet is exactly like Earth, but is currently experiencing an ice age.

Planetary climatology is one of the most complex subjects in world creation, so no godling should feel inadequate at a world whose climate is not 100% accurate. Although striving for perfection and realism brings its own sort of accomplishment, you should always weight the effort verses the return on every part of world building.

Step One: Example

I'll record my thoughts while creating my world along with each step. Step one is easy for me, as I don't want to add any more complications than necessary. I'll create a world that's the same diameter as earth, the same distance from its sun, the same daily and yearly cycles, and with an axial tilt of 24° . This allows me to focus on other matters right now. My flat world will have to wait.

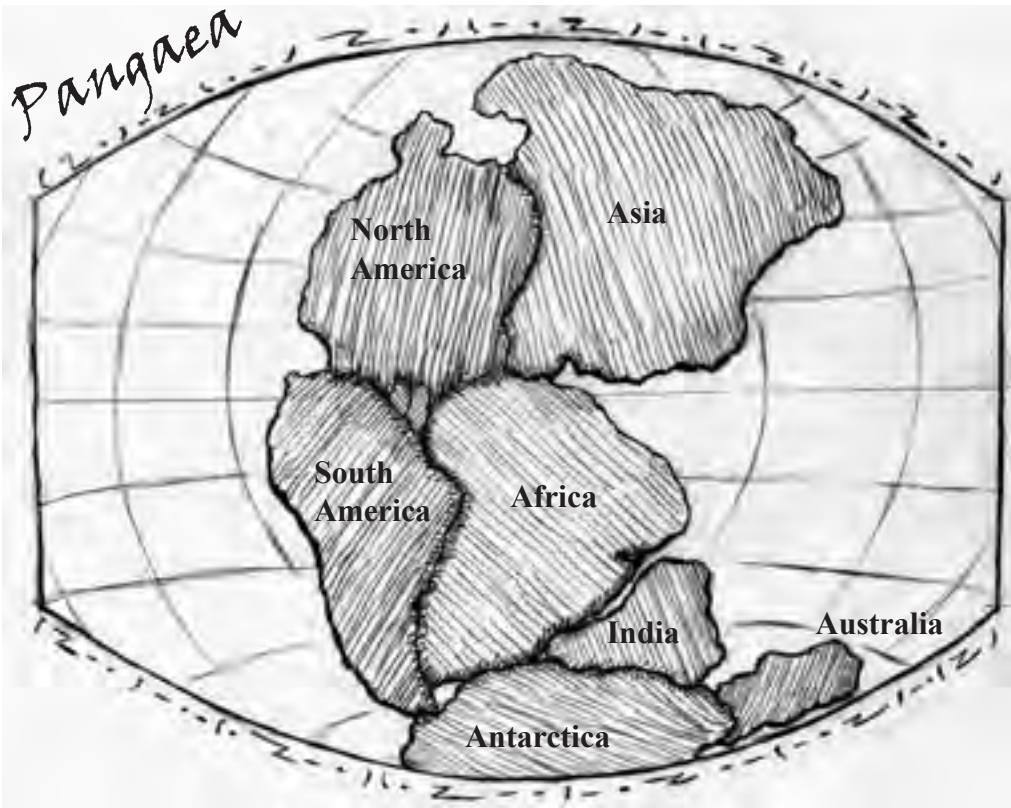
Step Two: Continents

Continents are striking features of any map, but they are merely the tips of larger plates that float along the world's surface. Plate tectonics describe the very slow thermal convection system at work inside the planet. This slow convection brings deep magma to the surface while pulling crustal material down. In this process, continents slowly move over the surface of the world. Tectonics elegantly create many geological phenomenon, most notably mountain formation, and allow us the joy of watching our continents move around like the hardening crust of cooling gravy. You may, of course, create a world where continents move for reasons other than tectonic activity, but you will have to supplement the natural geothermal forces with your own magic. I would not suggest

No Seasons or Hyper Seasons?

Axial tilt determines many vital aspects of a world. Choosing a tilt far from Earth's leads to a very different world. A world with a 0° tilt has no seasons because the sun is always in the same place in relation to the planet. Each individual location on the planet receives the same amount of sunlight all year round, making day and night the only temporal variations in solar energy. In order to achieve a 0° tilt, the equator lines up with the plane of ecliptic, the plane that passes though the sun and the every point of the planet's orbit around the sun. This would radically change the appearance your world, given Earth's reliance on deferential temperatures in climate, erosion, and other world-shaping phenomenon.

A world where the poles lie upon the plane of the ecliptic (90° tilt) is in even worse shape. Nearly half of the planet has a never-setting summer sun while the other half has a never-rising sun. Spring and fall are the time of rising and setting suns, and the equator is the best place for the growth of glaciers. Mass migration is a possible solution for Earth-like life to survive in such a world, though inhabitants of this type of world probably rely on magical energy to provide other survival methods.



such a course of action. Besides larger expenditure of magic, removing tectonics also affects the ecological aspects of your world.

How do you start building a world? Start drawing shapes. Don't focus on making good coastlines or craggy fjords. Just start placing general blobs where your landmasses are at the current time. To mimic Earth, focus on three to five large landmasses with one to three of them having small isthmuses connecting two larger "continents." This instantly provides a new world with the "right" feel with very little effort on the part of the creator. If something isn't pleasing, simply move on to the next idea.

After placing landmasses, consider the plates they rest on and how they could have moved through time. Every landmass is the part of a plate of rock that "floats" along at the surface of the planet. Plates generally extend miles into the ocean before ending. For reference from the base world, South America abutted North America and Africa; Africa abutted Eurasia, North America, India, and Antarctica; and Australia abutted India and Antarctica.

To simulate this effect in your world, take the landmasses you created and fit them together like pieces of a puzzle. Don't worry if you have to shave pieces off or add a land bridge somewhere. In geologic time, oceans rise and fall, continents crash into each other, pieces cleave off larger plates, and plates separate. When creating a world, you have the advantage of dictating history rather than recording it. After making these modifications, notice the boundaries where the plates previously intersected. There's a good chance that mountains form at these intersections. If mountains aren't there, hills may be. This is not the only method of creation, though creating a new world "with age" is fairly common. Most gods have little desire to wait the billions of years it takes the universe to naturally create intelligent life.



Step Two: Example

Please reference the map provided. I've drawn out some hasty coastlines for two large landmasses connected by small isthmuses along with a single large island/continent. You'll notice the peninsula on continent B jutting out westward. I drew this because I like the shape. However, this probably means that that peninsula is mountainous since almost all such peninsulas from our base planet are mountainous. There are some exceptions (Florida), but most peninsulas are mountainous (Italian, Iberian, Malaysian, Kamchatka, Scandinavian, Korean, Baja). This also means that I've probably got a subduction zone offshore because most of these peninsulas do as well. I'll keep that in mind as I go along.

I've also drawn dotted lines showing where my continents linked up in their pangea stage. This will help me place my mountains in the next step. If you'll note, I've placed the equator, the tropic lines, and the arctic lines (24° from the equator and 24° from the poles respectively) based upon the tilt decided upon in step one. This isn't important now, but it does impact on weather later on.

Step Three: Mountains

Once continents have been roughly outlined, and you've gone back in time to crunch all the continents together, placing mountains becomes a lot easier. Mountains form in a number of ways, the majority of which result from tectonic plate collision. Plates collide in three different mountain-building ways: oceanic plates collide with continental plates, oceanic plates collide with oceanic plates, or continental plates collide with continental plates. Mountain creation is generally a coastal affair. The majority of inland mountains were once near a coast, although some are the result of uplifting or folding.

Mountains Formed by Collision

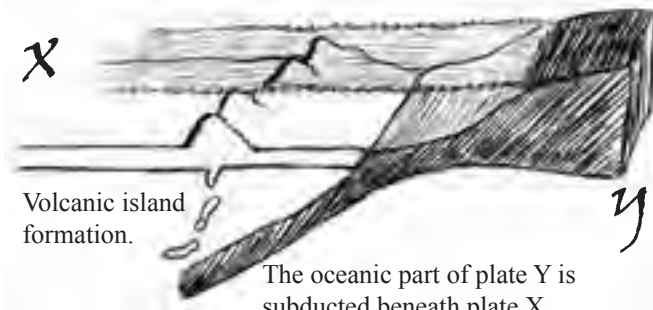
Whenever a continental plate meets an oceanic plate, the continental plate pushes the oceanic plate underneath it because continental material is less dense. This collision, known as subduction, thrusts the continental plate upward and creates mountains. At the same time, subduction forces the oceanic plate downward, creating subduction zones, the deepest of which are called trenches. As the oceanic plate moves down, oceanic material re-melts and often works its way to the continental surface, forming volcanoes. Shallow-focus and deep-focus earthquakes usually accompany oceanic-continental mountain building, so don't put your favored race there unless you're willing to periodically watch everything they build fall down or get covered with lava. When two oceanic plates meet, either plate could be the one subducted, depending on the direction of movement. The subduction zones of two oceanic plates usually result in deeper oceanic trenches. Instead of forming mountains, two colliding oceanic plates form a string of volcanically created islands. When two continental plates collide, known as suturing, both crustal plates resist subduction, but eventually one yields, forming massive mountains. Continental collisions don't form volcanic ranges, but they create many shallow-focus earthquakes.

Mountains Formed by Vulcanism

Mountains also form independent of tectonics, based solely upon vulcanism. Vulcanism is the movement of magma from the interior of a planet to the exterior. One common type of volcanically formed mountain is the dome mountain, which forms when magma pushes upward into the crust of the earth. Laccoliths, large bodies of slow-moving magma, form between horizontal layers of preexisting rock. The magma is so thick that it resists flowing. Meanwhile more viscous magma feeds into the mushroom-shaped laccolithic dome and forces the thick magma upward. The dome

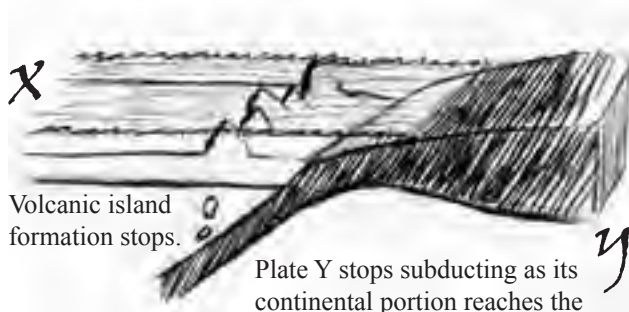


Suturing and Mountain Building



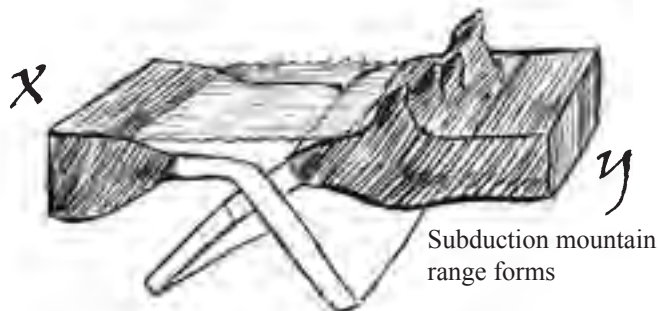
Volcanic island formation.

The oceanic part of plate Y is subducted beneath plate X.



Volcanic island formation stops.

Plate Y stops subducting as its continental portion reaches the subduction zone.



Subduction changes direction. Now X subducts under Y.

Subduction mountain range forms



Continents X and Y crash together, increasing the subduction mountain range.

mountain's creation process produces rounded-top chains, the Black Hills of South Dakota serving as a good example.

Vulcanism also results in the most obvious mountain creation—volcanoes. Although volcanoes are usually associated with subduction of tectonic plates, some places are simply “hot spots,” or places that allow magma to rise near the surface. Although volcanoes are spectacular and dangerous, they are not very good mountain builders. Mountains chains built predominately by volcanic activity are usually shorter (in length and height) than mountains built in plate collision.

Rifting

With plates crashing into each other and forming mountains, it stands to reason that there are other places where plates are drifting apart and forming new crustal material. Divergent boundaries are highly volcanic areas, and they form rift valleys lined with mountains when a continental plate splits. Divergent boundaries are responsible for breaking Earth's Pangea around 200-135 million years ago, setting the pieces adrift into their current locations.

Mountains to Molehills

Mountains compose 11% of the continental surface. There are unlimited possibilities when creating the geologic history of your world, but this work directs the focus on mapping the mountains. For more information and detail, consult your gnome or a historical geography tome. Armed with the knowledge of where and how mountains form, you now have the tools to map mountains in your world.





First, consider the giant proto-continent you formed from smashing your current continents together. Consider placing mountains where two continental masses collided in the imaginary proto-continent's history. Also look at the intersections or boundaries that later formed unique continents from the proto-continent. 20-40% of these boundaries have mountain ranges associated with them. Many mountains form after the proto-continent breaks up. For example, smaller continental plates calve off the major plates, which then crash into a larger continental plate. Both the Alps and the Himalayas formed in this manner.

Now consider the continents' current coastlines and decide which of them have mountains due to oceanic plate subduction. Roughly 25-50% of all mountains are associated with oceanic plate subduction. To give a familiar flavor from Earth, try to place your subduction mountains north to south. The two major subduction mountains on Earth (Rockies and Andes) run north to south.

The remaining mountains formed in proto-continent period are more difficult to place. Older mountains, like the Appalachians, often result from complex series of collisions, subductions, and accretions. Older mountains may be placed just about anywhere on the map, and their placement goes hand-in-hand with the placement of uplift or volcanic mountains. A godling must rely upon his good sense when placing the remaining mountains. Again, mountains compose about 11% of the continental surface.

The final thing to consider when mapping mountains is their height. Which mountain ranges are rocky, tall, and forbidding, and which mountain ranges are rounded, shorter, and more passable? Mountains that are currently growing due to oceanic subduction or continental suturing are rocky and tall, becoming less so as they age. The mountains that are not growing may be rocky and tall or rounded and low, though only the oldest mountains, whose growth stopped prior to the break up of a proto-continent, become rounded. Mountains created by volcanism are usually rounded and shorter, regardless of their age. It's also not unusual for a mountain range to undergo several different phases of mountain growth, like the Andes. The Andes are rather old mountains, some parts six times as old as the Alps, but they look "brand new" due to current growth from oceanic subduction.

To use more examples from Earth, the Alps are older than the Himalayas, yet both ranges are rough and rugged, although the Himalayas are much more so. The Appalachians are very old, and they show their age. Incidentally, the Appalachians experienced various mountain-building periods similar to the Andes, but it has been a very long time since the last of the series of mountain-building episodes occurred in the Appalachians, which accounts for its aging appearance.

Step Three: Example

I've filled in the mountains on the map. Mountain ranges A and D are formed by the collision of continents A and D. Range B results from continent A and B splitting as well as from subduction. When a rift occurs, one plate usually goes off in one direction and the other continues its path. This often creates a new subduction zone since one of the two plates isn't moving exactly along with the rift's movement. Mountain range C is pure subduction while mountain range E is a mixture of separation and collision. The split of continent E and D formed the north-south part, and the east-west part is from a plate that separated from E and then returned again. Range BE is subduction created.

But I'm jumping ahead of myself here. What I really did was put down the mountains where I thought they looked good, where they pleased my eye after looking at atlases for a long time. I came up with how they were formed after I already put them on the map. This is the great freedom of trusting your eye when placing mountains. If you look at atlases, find their patterns, and mimic them somewhat, the reasons for your mountains' existence become almost self-explanatory.

Step Four: Islands and Archipelagoes

Islands play integral parts in every world, teeming with exotic locals, expensive spices, treacherous misty rocks, and unique flora and fauna. Islands come in different sizes. Some are practically continents in and of themselves, while others are nothing more than the eroding tops of volcanoes that managed to break the water's surface.

Islands Connected to Continents

Larger islands are commonly caused by variations in sea level. These islands are actually part of a large continental plate, but they appear to be separate due to the current water level. The UK islands are a great example. They are on the same plate with the rest of northern Europe, but they are separated by water due to the current ocean level. Should water levels drop, as in the last Ice Age, a land bridge forms between England and France. Another good example is some of the islands off the Southeast Asian coast. To place this type of island in your world, slightly expand the continents in certain areas and create islands by inserting a shallow causeway or sea between them and the main continent.

Islands Formed By Rifting

Some of the largest islands are small sections that broke off larger continental landmasses, forming their own plate. The distance between islands on rifted plates and their parent continent indicate how old they are, the oldest islands farther away from their parent continent. Madagascar and Greenland are good examples of islands that were once part of a continental landmass. Another good example is the Indian Sub-Continent. At one time it was an island calved off of Africa, which collided with Asia, building the Himalayas. Place these islands by cleaving off part of a continent and drift the plate away from its parent continent, the oldest rifted islands traveling the farthest from their parent continent. Rifted islands cannot travel over oceanic subduction zones to get to their present location. Occasionally islands migrate long distances to eventually accrete into new continents and form mountains, and such rifted islands may have subduction zones between them and their new continents in the period before they accrete. In general, the farther an island drifts from their parent island, the more unique their flora and fauna, but this is better addressed in the ecology section of this work.

Islands Formed by Volcanic Activity

Volcanic activity is responsible for the majority of the islands, either at subduction zones or hotspots. At subduction zones, where an oceanic plate is subducting under a continental plate or another oceanic plate, volcanic activity often creates a string of islands. These island chains and their volcanoes usually curve due to the spherical nature of planets. Just as pressure applied to a ball creates a rounded dimple, the pressure of colliding plates on a spherical planet results in curved subduction zones, volcanoes, and islands. To place this type of island, look for areas where subduction occurs, especially around oceanic trenches, where two oceanic plates collide. Continental plates often extend out into the ocean, sometimes hundreds of miles. When islands form in the subduction zone of extended continental plates and oceanic plates, the island chains also curve. Many great island chains form this way on Earth; Japan, the Philippines, the Aleutians, the Caribbean islands, New Zealand, and most of Indonesia are creations of volcanic activity in subduction zones.

Volcanic activity in oceanic hot spots also create islands, though must smaller in scope. Most hot spot islands and island chains are less than 100 miles in diameter, usually around 20 miles in diameter. Since hot spots are stationary and oceanic plates are not, island chains form as volcanoes go through active and dormant stages while





Island Worlds

Though a popular idea among godlings, a world consisting entirely of islands is extremely difficult to achieve without great expenditures of magic. The majority of continental landmass is felsic rock, so light that once it is extruded from the earth, it strongly resists subduction. On the other hand, oceanic crust is made from dense mafic rock, which is why oceanic crusts usually subduct under continental rock. Felsic rock's lesser density results in continental landmasses because extruded felsic rock stays on the outside of the crust.

Though this process makes justifying archipelago worlds more difficult, here are a few non-magical suggestions. Perhaps the world is very young, and all the felsic rock has yet to surface and form large continents. Perhaps only the known world is an archipelago. For example, thousands of miles filled with islands form where two or three oceanic plates meet in the middle of a large ocean, and their inhabitants do not know of the outside world. How the intelligent creatures got there, and how they forgot about the world they came from is at your discretion, but such is the art of composing great creations.

the island's plate moves over the hot spot. Hawaii is an excellent example: as the oceanic plate moves, the hot spot remains stationary, creating the islands in sequence. The oldest Hawaiian island is Kauai (5.6 million years), and the youngest is Hawaii proper (less than 1 million years). The youngest island tends to be the largest, while older islands are usually smaller. Since most are formed by volcanic activity, oceanic islands tend to be rather mountainous. The newest islands are the rockiest, while older ones are less rocky.

Hot spots are places where the crust is thinner, allowing the magma to escape to the surface. Oceanic island-forming hot spots are easy to locate because no one is certain why they form in the first place. Simply put them where you like. I recommend placing hot spot islands, like Hawaii, at serendipitously convenient places for ship travel. Nothing quite beats the excitement of a long voyage by ship to a strange new island. Unlike Hawaii however, the majority of hot spot islands form in more volcanically active areas closer to subduction zones.

Hot spots also occur on continental plates, though 75% of Earth's 40+ hot spots are oceanic. Yellowstone is an example of continental hot spots, where they create surreal landscapes full of geysers, hot mud pits, and volcanoes. Again, wonderful places for adventure.

Archipelagoes

Archipelagoes are collections of islands that extend from larger bodies of land. The term applies to both massive collections of islands, such as the western portion of Indonesia, as well as long extensions of smaller islands, such as the Aleutians. Archipelagoes are usually island chains resulting from volcanic activity in subduction zones, although a few are the result of sea level variation. Really large collections of islands are the result of several subduction zones in close proximity to each other. For example, volcanic activity from three major subduction zones formed the thousands of islands that constitute the Indonesian islands. They are usually mountainous since most archipelagoes are created through volcanic activity in subduction zones.

Plates

Though we have been discussing tectonic plates and their role in mountain and island formation, it is far easier to put the plates in after placing major mountains, islands, and archipelagoes in your world. Remember that your responsibility is mapping the world in its current time. All geologic history may be retro-engineered. First place subduction zones on the map beside the mountains, islands, and archipelagoes they created.

Then identify the areas where upwelling magma forms new crustal material and drives two plates apart or splits one plate apart. This rifting creates ridges as two parallel mountainous lines form on either side of the new crust. Most of the ridges on a planet are oceanic (roughly 90%), though continental rifting is responsible for forcing the continents apart. Continental rift valleys widen and eventually fill up with water, creating separate independent continents. As new material expands a rift valley, plates move away from the ridges. Place major ridges in the ocean, usually where subduction zones occur on both sides of the rift. In the Pacific Ocean, the ridge pushes new oceanic plate material into subduction zones all around the ocean, creating the Andes, Japan, and the Aleutians.

Oceanic plates moving away from rift valleys do not always subduct under another plate. Sometimes they travel together in the same direction. For example, the growing Mid-Atlantic ridge pushes both American continents west and Africa northeast, but no mountains are forming along the east coast of South America and the west coast of Africa because those continental plates are traveling in the same direction as the oceanic plate. In some cases, oceanic and continental plates slip alongside each other when moving in a similar direction. This creates great slip faults like the San Andreas Fault and produces a lot of earthquake activity. Oceanic ridges are not as important as other plate activity, but they cement what is going on tectonically on a new world and point out areas that experience a significant number of earthquakes.

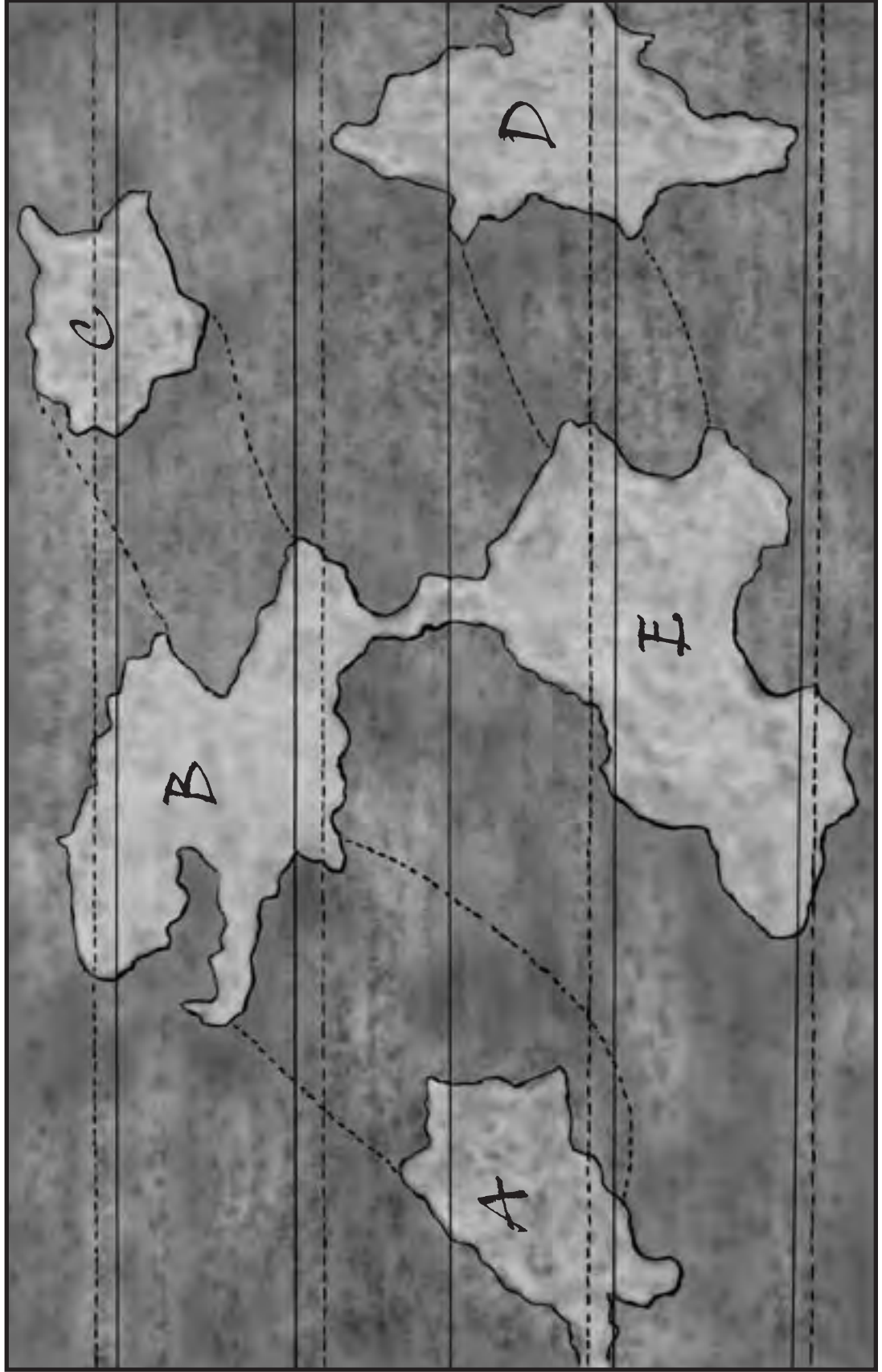
Step Four: Example

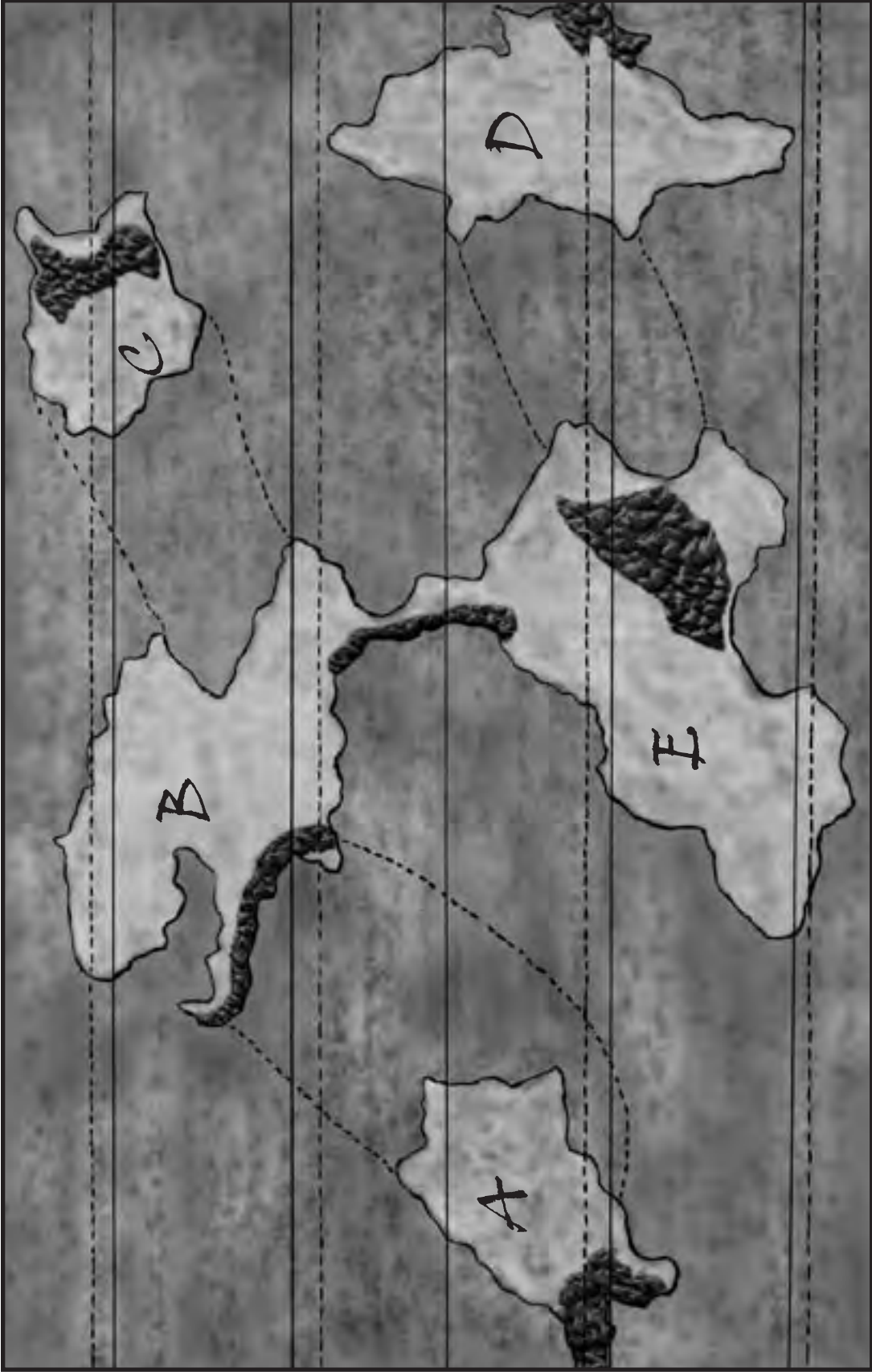
I've determined the basic (very basic) plate structure of my world. There's a large rift (oceanic ridge) between continents BE and CD. This follows along with how they fit in the pangea stage. There's also a ridge between A and B for pretty much the same reason. The subduction zone off B's peninsula is where the oceanic crust (created at the rift) is pushed under B's continental plate. This means that mountain range A formed both by rifting as well as subduction. I've also added the two subduction zones that are creating mountain ranges BE and C. This could mean that at one time continents B and E were separated and the subduction zone linked them together through its mountain building, but it doesn't have to. I've also included a small oceanic subduction zone offshore of E. This is where the ridge is subducted under the continental shelf of E (which extends under the water). I've only placed one slip plate in the ocean between continents AB and E. I've also indicated the suturing on continent E where its calved island is crashing back and the suturing between continents D and A where they're coming together.

With this in mind, placing islands on the map is fairly simple. The large peninsula on B gains an archipelago, and islands form over the subduction zone offshore of E. More islands form along the slip plate. I've also placed some continentally connected islands (like England) and a few hotspot islands (like Hawaii). This gives you rough guidelines when you actually place your islands in creation. Namely, this lets me know where to put larger islands and why they are there. A more thorough look at plate structures would also provide more islands, but I'm only summarily addressing the plate details.



Mapping your World ~ Steps 1 & 2





Mapping your World ~ Step 3

Mapping your World ~ Step 4



Interlude

Kierian threw down his pencil and ran his hand through his hair. The prim gnome raised his brow and cast an inquiring look from behind worn lenses. "Come across a snag?" Noj asked continuing his work.

"I don't understand," Kierian stated simply.

"Your intellect is more than adequate for the task at hand." The quill scratched the parchment, cutting deep and filling the wound with ink. "Perhaps you should try looking at the map upside down. A new perspective does wonders..."

The godling pushed away from the desk with unexpected force. "No, I understand the map," he answered indignantly. The gnome lowered his quill and raised his head. Silence reigned. Noj waited for a satisfactory explanation while Kierian grasped for words.

"I'm a god, right?"

"Yes and no," the gnome answered forthright. "You have a sort of divinity with the potential powers of a god without the actual authority of the gods."

Kierian's head nodded ambivalently. "Ok, so I'm not a full-functioning god yet, but I've definitely got more abilities than a mortal." A point Noj readily corroborated with a nod.

"Then why can't I just make it up? Why do I need all this?" Kierian spread his arm across his packed desk. "Pens, inks, paper, rulers, t-squares, balances, and this circular thing."

"It's called a compass," Noj injected.

"I don't care what it's called. I'm not using it," decreed Kierian.

Noj removed his spectacles with a serious countenance. "It's not a matter of 'can' and 'cannot.' It's a matter of 'should' and 'should not.' If you want to put a river there, fine. But it's not consistent with the remainder of your map." He pulled a pointer from his waistcoat. "This should be the dry side of the mountain. Sustaining a river there will be a constant drain on your magical resources. As for the accoutrements of the





trade," he returned his spectacles on the crook of his knobby nose, "methodical planning before creation is advisable for someone of your inexperience." Noj stared down through his small circular lenses. "There is little more horrific than creation gone awry."

Kierian's shoulders rolled forward under the austere gaze, collapsing his otherwise proud, taut frame. He couldn't name the weariness that overcame him. He had ample rest and sustenance and hardly lifted his sword, yet he hadn't felt so tired since that forced march through the Okepa Swamp. He needed distraction. Only nothing here was real. The dapper gnome was the closest thing to company, and his interest lie in writing, maps, and machines. The godling took a pencil in hand, twisting it between his fingers.

"How many worlds have you built with godlings?"

"One hundred seventy-two. Only in the service of three godings have unsatisfactory worlds been created." Noj looked up from the adding machine. "And you're not going to be the fourth."

"What was your favorite world?" Kierian asked nonchalantly, brushing aside Noj's ramrod determination.

The old gnome stared off into distant memories. "Each one has its moments. There was Hawtho, created by Lilia Goddess of Song, Bringer of Harmony, the Walking Grace, etc. It has the loveliest waterfalls. And Xarkia has striking fjords. Grulok, God of the Forge, created that world. Hasn't done too much after the task. I think he was relieved that his world was satisfactory and didn't want to attract anymore attention." Noj chuckled to himself.

The godling propped himself upon his left arm. "So does everyone get a gnome? Or are you but one builder?"

Noj looked up with utter surprise. "Didn't you know? Gnomes are the builders of worlds." Noj nudged some tools in Kierian's direction. "It's time to use the circular thing and set environs down."

Kierian sighed. "It's called a compass."

Ecology

All life depends upon the flow of energy. Energy only comes from a few precious sources: the sun, geothermal energy, and magic. Of these, the vast majority of a world's energy comes from the sun, followed by magic, and then geothermal sources. Each energy source has creatures that turn it into matter. Every bit of matter has creatures that turn it back into energy. This is the grand cycle, and its complexity is stunning.

Though the sun radiates massive amounts of energy, life subsists on a small percentage of all the heat and photochemical energy that hits the planet. Solar energy is the primary driver in a planet's ecosystem, mainly through warming the planet unevenly. The discrepancy of heat creates weather and greatly affects photochemical processes, which create energy used by plants in photosynthesis. Geothermal energy, though orders of magnitude less than the sun, facilitates life in places where the sun cannot reach, like underground or on the sea floor. Magic, on the other hand, flows differently than either the sun's or the earth's energy.

Magic is the greatest force in the multiverse, and the only thing comparable to its pervasiveness is light. Light is everywhere in the universe, and only within solid bodies is light excluded. Unlike light, magic permeates everything. It is a critical building block of the multiverse, and even nothingness' main component is magic. Even vacuums are made of magic. Although everything is made with some magic components, magic, as the ability to use powers or spells to alter reality, isn't available everywhere. Some places have very low levels of magic, in which the typical functioning of magic can't occur. But even these places have some magic, just infinitesimally small amounts. Unlike other planetary energy sources, magic is alive and sentient with a will of its own. Magic is the body of a massive entity, and the rest of existence depends on it functioning properly. It is almost as if the multiverse is some sort of parasite on a giant magical creature.

Cautionary Note

For every magical planet, there are dozens of non-magical ones (like our base planet), yet the multiverse demands certain constants. Despite the discrepancy of available magical resources, basic catalytic processes (like adaption, natural selection, and evolution) shape life on the most magical planes and even affect how life interacts with the body magic. Though some gladly expend vast amounts of magic to see the world of their imagination, remember that every action has an equal and opposite reaction, even with the body magic. Our reach and power are orders of magnitude greater than mortal magic practitioners, and we are capable of creating greater magical reactions upon ourselves. As gods we must always be aware of the magic budget in the material plane, build our worlds with as little magic necessary for its survival, and learn to always ration our power. In a sense, even gods must adapt to their environments or die.

Magical energy permeates everything on a planet, but it is not a static force. Unlike matter, which always seeks an even distribution state (entropy), magic always seeks an uneven distribution state. To think of it in other terms, matter is by nature lawful while magic is by nature chaotic, although this is a hotly debated topic among the gods. Magic is always moving, either through ley lines or magical topology, and it strongly resists being chained to a single place. It is this resistance to stability that makes preparing arcane spells so arduous and the production of magical artifacts so draining. But there is much to discuss before the inner workings of magic.

Life Roles

All of this energy flowing onto, into, and through a planet is put to good use. Each energy



source is consumed/used by organisms (most very small) that turn it into matter. Other organisms eat the original organisms, creating food chains and food webs. But before embarking on food webs and chains, we must look closely at the different life roles that cycle the energy on a planet.

All life can be classified into three basic groups: autotrophs (organisms that produce organic material from inorganic chemicals and some source of energy), heterotrophs (organisms that require a supply of organic matter or food from the environment), or magiotrophs (organisms that can produce organic material from magical energy alone). Autotrophs form the basic building block for life on any planet. They take inorganic chemicals and transform them into organic tissue via light, heat, or other chemicals. Some examples of autotrophs are photosynthetic bacteria above ground, most plants above ground, and chemosynthetic bacteria at hydrothermal vents or underground. Heterotrophs are the organisms most creatures are familiar with like frogs, cows, lions, fish, and birds. The vast majority of mobile, multi-celled creatures are heterotrophs. Magiotrophs are very similar to autotrophs except they don't require anything but magic to create organic material. Most magiotrophs are magiotrophic bacteria, although there are some larger creatures that survive solely on magic, such as the feared disenchanter. Some creatures cross these groups combining various feeding aspects. Carnivorous plants are both autotrophic and heterotrophic since they cannot live without either energy source, and many creatures are mixtures involving magiotrophic behavior. On magical worlds, almost all creatures use some amount of magic as "free energy" to build tissue. Those creatures that don't utilize magic as an energy source usually have a selective disadvantage, although in some worlds or in magical deserts they have a selective advantage.

We can further divide the heterotrophic group in feeding patterns. Biophages (organisms utilizing living material for the majority of their energy), saprophages (organisms utilizing dead material for the majority of their energy), and magiophages (organisms utilizing magic material for the majority of their energy) all occupy the heterotrophic group. For all practical purposes, there are few magiophages that cannot be treated as biophages or saprophages because they gain access to magic stored in tissue similar to how biophages and saprophages gain access to energy from more traditional sources. In other words, most magiophages eat living or dead tissue, and they simply draw the majority of their sustenance from the magic in the tissue as opposed to the tissue itself. However, there are some creatures, like the disenchanter and many undead (or any vitaevorous or psionivorous creature, for that matter) that don't mimic biophages or saprophages.

Food Chains and Food Webs

There are two food chain systems on every planet: the grazing food chain and the detrital (decomposition) food chain. Autotrophs and magiotrophs form the foundation of every food chain because they're the creatures that don't require organic material to create life. Contrary to appearances, the detrital chain has the most energy going through it at any one time. Only deep-water aquatic systems (with their characteristic low biomass, rapid turnover of organisms, and high rate of harvest) have more energy flowing through the grazing chain. But if you're a gnome or a halfling, you may not be so surprised being intimate with the vast amount of life contained in the soil and its detritus, or so I've been informed.

The grazing food chain is most easily observed. Deer in the forest, rabbits nibbling on lettuce, insects eating everything green, cattle ruminating on grass, and gorgons in their rocky lairs all represent basic consumer groups of the grazing food chain. Only a small percentage of an environment's net primary production is used by herbivores: only 2.6% in poplar forests, while 30-50% on heavily grazed grasslands. Below ground herbivores like nematodes, scarab beetles, and ground beetles account for the vast majority of herbivorous assimilation.



The detrital food chain is the major pathway of energy flow because grazers utilize so little of the net production. Millipedes, snails, mushrooms, cave crickets, maggots, slugs and most of the oozes (although some can be quite predatory) are all examples of detrital chain organisms. They play an important, if somewhat disgusting, role in the maintenance of a healthy ecosystem. Everything that's not eaten by herbivorous grazers eventually ends up as fodder in the detrital chain. We're all food for the worms.

The detrital chain is based upon decomposition, the reduction of energy-rich organic material by consumers (generally detritivores and decomposers). Whereas photosynthesis and magiosynthesis involve the incorporation of solar energy or magical energy into organic matter, decomposition involves the loss of heat energy and the conversion of organic nutrients into inorganic ones. To test this theory, just go to a farmer's compost heap and stick your hand in. You'll find that the inside of the heap is quiet warm because of all the heat lost through decomposition. Decomposition includes many processes: the leaching of soluble compounds from dead organic material, fragmentation, bacterial and fungal breakdown, consumption of bacterial and fungal organisms by animals, excretion of organic and inorganic compounds by organisms, and the clustering of colloidal organic matter into larger particles. Every non-magical animal is involved with decomposition, as its waste products are primary source material.

These two chains are easily represented thusly. The grazing chain is light/magic > autotrophs/magiotrophs > herbivores > carnivores > top carnivores. The detrital chain is detritus/magic > microsaprophages/magiotrophs > microbial grazers > microbial predators > top detrital predators. There are many other relationships occurring at the same time that cannot be explained simply, but better seen pictorially.

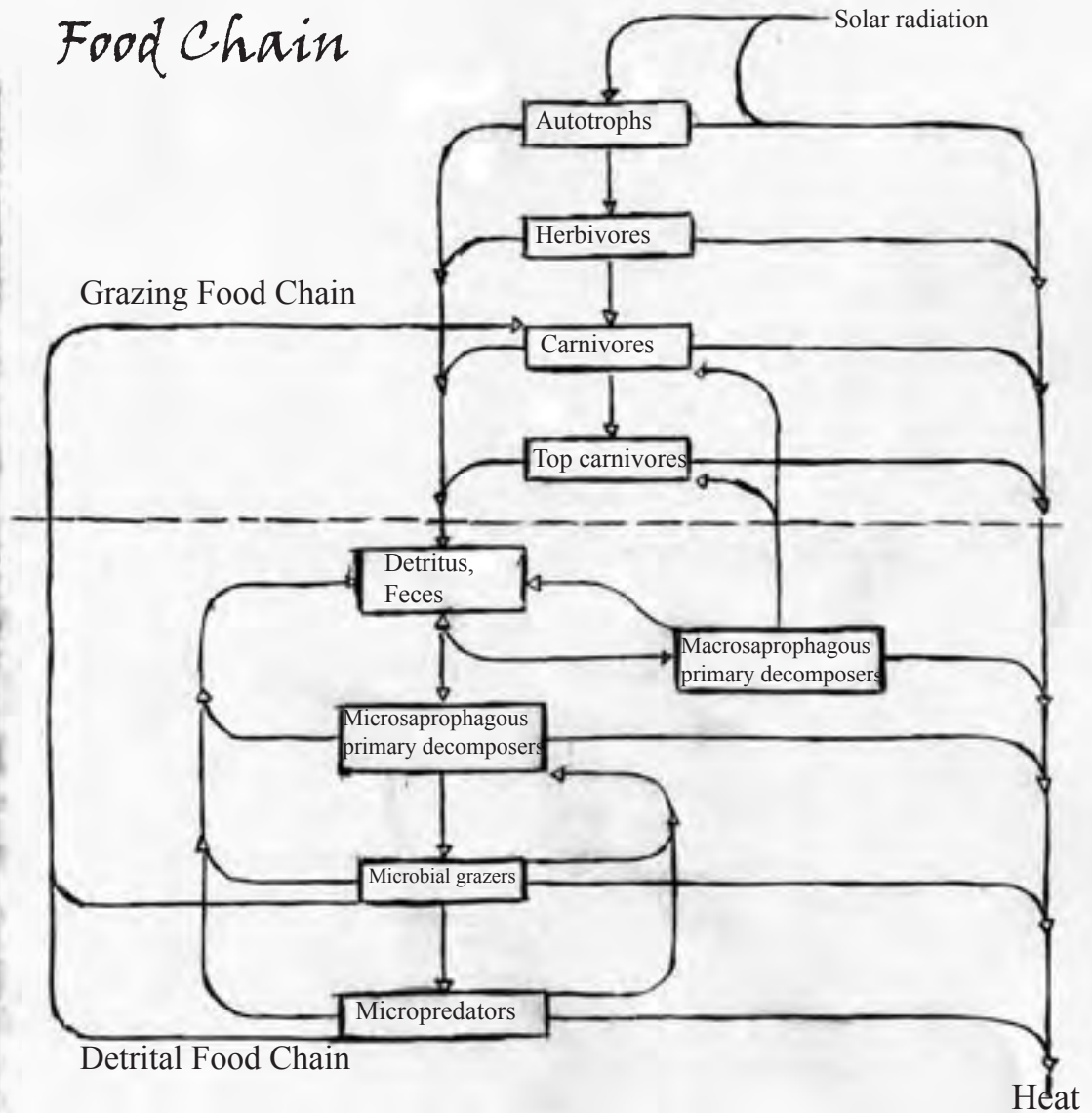
But most relationships in nature are not simple, straight-line food chains. Numerous food chains interlink into complex food webs, with all links leading from producers through an array of primary and secondary consumers. Interestingly enough, food webs (once unraveled) rarely exceed four links because every new layer adds another level of energy transfer inefficiency. Highly productive ecosystems rarely support more links, termed trophic levels. They usually support more species and have more complex webs instead of longer ones. The few land-based ecosystems that exceed four links usually stress magic as a primary energy source. Food webs are usually shorter in fluctuating environments (temperature, moisture, salinity) and longer in environments that have more stable conditions. Highly stratified environments, like forests or pelagic water columns, have longer food webs than poorly stratified environments, like grassland, tundra, and stream bottoms. The widest food webs (those with the greatest number of herbivores) tend to be the shortest while narrow food webs have the greatest fraction of top carnivores. More complex food webs are actually less stable than shorter ones and are easiest to disrupt. Generalist species most easily invade simple food webs while specialists, capable of exploiting a restricted source of energy, are best able to invade a complex food web.

One would think that omnivores (those who can eat both meat and plant) would dominate food chains, but the reality is quite different. Although an excellent survival mechanism, omnivores tend to be generalists and hence, cannot digest either meat or plants to the efficiency of true carnivores or herbivores. This means omnivores are not highly prevalent in food chains dominated by larger creatures. Most omnivores can only feed on adjacent trophic levels, but detritivores, insects, and their predators and parasitoids can often feed on non-adjacent trophic levels.

Predators may overlap in their exploitation of prey species. Many predators feed upon mice, for example. Top predators may feed on a number of species, or they may concentrate on a few particular species found on trophic levels right below them. In general, the more species of prey an animal exploits, the fewer predators it faces. This isn't a truism, but it helps indicate a creature's general trophic level in its environment.



Food Chain



Food web invasion often has serious disruptive consequences for the web. Introducing a new predator can result in a simplification of the food web; should a new predator out-compete existing predators, the food web becomes less complex. Removing a key predator can have just as disastrous effects. Usually the trophic level just under the predator (the trophic level where most of its prey resides) experiences a population increase. This increased population eats like mad, depleting prey on the trophic level under them. Sometimes the effects are so drastic that starvation hits the increased population (who's missing one of its prime predators), which affects any other predators that eat them as well.

Predation

Predation occurs when one organism feeds on another, and the prey dies because of this feeding. Predation is more than a simple exchange of energy; it's a complex relationship between two or more species. Predators cannot survive when their prey population is too low, and prey cannot survive when predation is too high. Nature regulates the process where most predator and prey populations oscillate within accepted norms through the use of starvation.



As the predator population increases, it consumes a progressively larger portion of the prey population until the prey population begins to decline. This plentiful amount of food influences the reproductive rate of the predator population until the predator population eventually overshoots the availability of prey. The predator population declines until reproduction of prey more than balances its losses through predation. The prey population then increases, and the cycle begins again. In a balanced predatory-prey relationship, the prey is never quite destroyed while the predator never completely dies out. This is a simplification of the cycle, for it doesn't take into account genetic changes, stress, emigration, aggression, availability of cover, and difficulty of locating prey as it becomes scarcer. But for our purposes, it is adequate.

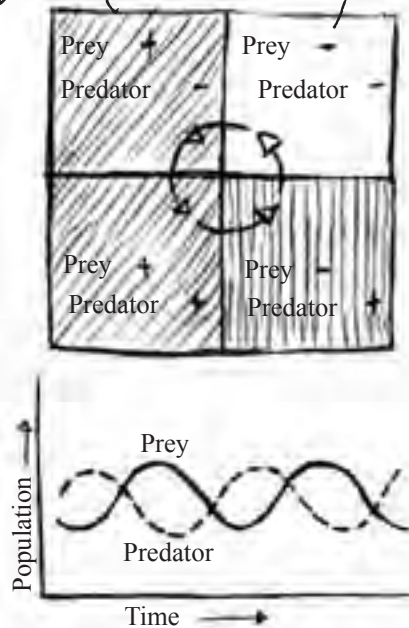
Predator-prey relationships are rarely singular. Most predators have a variety of prey to shield them from the worst aspects of the predator-prey cycle. Most predators also have seasonal prey depending upon what type of food is in abundance. For example, bears eat berries (seed eating is predation), fish, or honey (not necessarily predation unless the bear destroys the hive through his actions; if he doesn't its considered parasitism) in different ratios depending upon their seasonally varied abundance. This is beneficial for prey as well, giving them a greater chance in survival since they aren't the primary food source until they are in abundance. Although these multiple relationships are mostly beneficial, they do have their downsides. If one predatory species is very successful, their success reduces the food supply for the other predators that eat the same prey. This may exacerbate the predator-prey relationship and make downturns harder on the other predators. These other predators, in turn, take a larger amount of their other prey sources and influence more predators through those actions. Again, it is another causal behavior chain that is hard to predict.

Predator-Prey Systems: Herbivorous

Plant predation (although more precisely "plant parasitism" because most animals don't actually kill the plant they eat) is the building block upon which carnivorous predation stands. Plants transform water, nutrients and sunlight into edible material throughout every world. Cattle eating grass, squirrels eating nuts, caterpillars eating leaves, and deer eating tender shoots are all common, everyday occurrences of herbivorous behavior. Almost every plant is subject to some sort of herbivory, and a casual look shows its signs on leaves, bark, or fruit.

Although years of major insect outbreaks or overabundance in some herbivores can drastically increase consumption, herbivores generally consume about 6%-10% of all plant biomass. Though only a small percentage, small changes can have big impacts. Any removal of tissue like leaves, bark, stems, buds, roots, and even sap, reduces a plant's fitness level, though it probably won't kill the plant outright. A fitness reduction places the plant at a selective disadvantage to the other plants around it and lowers a plant's reproduction capability. This reduction in fitness especially impacts juvenile plants as they are already at a selective disadvantage against mature plants.

Predation Cycle



Trees usually compensate for this predation by increasing photosynthetic efforts in remaining leaves, but young, new leaves are particularly vulnerable. Since it takes more energy to make new leaves than they initially produce, leaves are a net loss to a plant until they fully develop. Once leaves fully develop, they pay back this deficiency and eventually become net producers of energy. When young leaves are predated, the total loss to a plant is greater than when an old leaf is predated. Most trees respond to defoliation with a flush of new growth (this is why gardeners prune) that drains resources otherwise directed toward growth or reproduction. Flush new growth after defoliation also draws from the tree's chemical reserves, which often exposes roots to fungi while the plant concentrates on its canopy. Severe defoliation and subsequent regrowth alters trees physiologically. Growth regulators become off kilter as they encourage a tree to bud at the wrong times, resulting in late-forming leaves. This weakens the plant to disease and insect attacks the following year.

Grasses have a different response to grazing. Unlike trees, grasses are low to the ground, protecting young tissue from grazers. Only the older tissue can be consumed by herbivores. Grazing stimulates production through the elimination of older tissue that is less photosynthetic than younger tissue. Some grasses can only maintain their fitness under grazing, and some dominant species disappear in the absence of grazing.

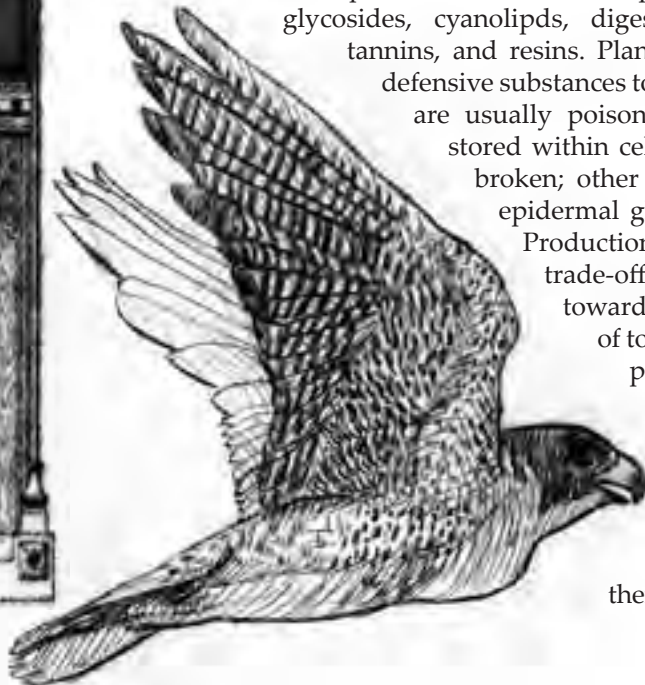
But the herbivorous predator-prey relationship also affects the predator. Plants, though seemingly passive, play a big role in the fitness of herbivores. For herbivores the quantity of food is usually not a problem, but the quality of food is. The complex digestive process needed to break down plant tissue and convert it to animal tissue requires high-quality forage rich in nitrogen. If there isn't enough nitrogen in the vegetation, an herbivore can starve to death on a full stomach. Unfortunately, most food is low-quality food, and plants make predation more difficult by developing various natural defenses.

There are two broad categories of plant defensive behavior. One category is large, long-lived, woody plants whose main defense is sheer mass. This defense takes a long time to develop and a great amount of energy. Massive-size plants also have slower defenses; for example, oak trees defoliated by gypsy moths don't increase the phenolic and tannin content of their leaves until a year later. The other category is shorter-lived plants that possess secondary substances that interfere with herbivorous metabolism,

such as toxic proteins like lectins and protease inhibitors, alkaloids, cyanogenic glycosides, cyanolipids, digestive-inhibiting polyphenols, terpenes, tannins, and resins. Plants react to predation by shuttling their defensive substances to where they're needed. These substances are usually poisonous to the plant. Sometimes they are stored within cells and only released when the cells are broken; other times they are stored and secreted by epidermal glands and function as a contact poison.

Production and storage of these substances are a trade-off for plants, since that energy is not spent toward growth and reproduction. Development of toxic defenses indicates a history of greater predation upon the plants, regardless of their current predation rates. But

even with these quick defenses a few herbivores (notably insects) have developed methods to detoxify and digest these plants. Some predators even store the plant's poisons and use them in their own defenses.



Bunny Trouble

Predator-Prey Systems: Carnivorous

A good example of how predation effects the development of prey is the humble lagomorph. These poor little bunnies are so predated upon by so many different species that they have resorted to eating their own feces as a survival mechanism. The rabbit hops out of its burrow, eats like mad, and then jumps back into his burrow as quickly as possible. Safe in his lair, the bunny poops his greenish "first-run" pellets. These have passed through his short digestive system once and are partially broken down. The rabbit then eats them again. The "second-run" through his digestive system absorbs the remaining nutrients, and eventually he deposits the dry pellets outside the burrow. This minimizes the amount of time he has to spend outside the safety of his lair while maximizing the amount of energy he gets from his food.

Carnivorous predator-prey relationships differ from herbivorous predator-prey relationships in one key manner: carnivores predate high-quality food, but usually don't have the required quantity. This dictates a different relationship between eater and eaten. Herbivory supports carnivory, therefore fitness of carnivores depend upon their ability to capture prey, while (at the same time) their prey must be fit enough to overcome plant defenses. In order to survive, herbivores must adapt to these pressures coming from multiple angles. But one thing should be stressed: carnivorous predator-prey relationships exist between carnivores just as much as they exist between carnivores and herbivores. Many carnivores prey on smaller carnivores.

More than herbivorous predation, the relationship between carnivorous predator and prey is strongly influenced by the prey's defenses and the ability of the predator to overcome them. Prey develops an impressive array of defenses in order to make the predator's task as unsuccessful as possible. Some species have developed pheromones to induce fright reactions in the other members of their population and even in members of closely related species. Arthropods, amphibians, and snakes employ odorous secretions to repel predators. Many arthropods possess toxic secondary substances taken from the plants they eat and stored in their own body while other arthropods, venomous snakes, frogs, and toads synthesize their own poisons. But prey develops more than just these defenses. Many creatures have developed camouflage defenses and cryptic coloration designed to hide from predators. Others use coloration, patterns, shapes, postures, movements and other behaviors that prevent detection. Flashing coloration, like extremely visible color patches or even bioluminescence, distract and disorient predators. Warning coloration, like the yellow and black coloration found in many bees and wasps, and mimicry indicates that the animal possesses some dangerous property such as a highly toxic poison or some other chemical defense. But these defenses rely upon some sort of initial experience with the prey to create an association between the color and some sort of unpleasantness. Other animals develop armor as their primary defense. Turtles, armadillos, clams, and many insects (mostly beetles) withdraw into their armor coat or shells when danger approaches. Another type of armor is more aggressive, but just as effective. Quills, like those found on hedgehogs, echidnas, and porcupines are modified hair follicles that present difficulties for most predators.

Behavioral factors have also provided a selective advantage to some species. Alarm calls alert many different types of species to nearby danger. Some animals employ mob tactics, either from a distance or by direct attack, to harass predators away from young. Others find that living in groups provides the simplest form of defense. The more they congregate, the less likely a predator attacks and the less likely that any one particular individual is lost through predation. Maintaining a tight, cohesive group (like schools of fish), make it more difficult for a predator to be successful. A final method





of defense used against predators is an unusual one. Prey time their reproduction into a very short frame and thereby create an environment where predators may simply take as much as they want without seriously threatening reproduction of the species because there is just too many prey. The predators become satiated in their feasting, and a certain number of prey survive to continue their species. This is a particularly common tactic for large ungulates, like the caribou.

Although prey develop effective defensive tactics, predators evolve three general behaviors that advance their hunting success: ambush, stalking, and pursuit. Ambush hunting involves lying in wait for prey to happen by. Alligators, lizards, frogs, and some insects typically use this method. Ambush hunting has a low success rate, but it requires very little energy. Stalking, common for many cats of all sizes, is a slow and deliberate process. The predator has a long search time but a minimal pursuit time. Pursuit hunting is used when the predator knows the general location of the prey. Pursuit time is long, however, so pursuit hunters expend more energy to capture and handle prey. Birds of prey, lions, and wolves often use pursuit hunting. In tropical climates, heat regulation often becomes a very important limiting factor for how long a predator (and prey for that matter) can run. Predators also employ cryptic coloration to blend in with their environment or break up their outlines. Some clever predators mimic their prey. For example, female fireflies mimic the mating flashes of other firefly species to attract males of that species. When they arrive, ready for some fun, they promptly kill and eat the male. Poisons are also a common development (spiders, snakes, scorpions, and shrews), and group attacks (lions, wolves, hyenas) are particularly successful.

Predator-Prey Systems: Magivorous

Magivorous creatures feed on magic, and magical predator-prey relations naturally develop in magical worlds. There are several different types of magivorous creatures, and they often display other predatory traits such as herbivory or carnivory. On many magical worlds, most simple creatures like deer or lions possess a bit of magivorous digestive capability, which allows them to digest some of the magic contained in the various tissues they consume, providing them with additional energy to increase fitness. There are four basic types of magivory: divinivory, arcanivory, vitaevory, and psionivory. Divinivorous creatures eat divine magic, arcanivorous creatures eat arcane magic, vitaevorous creatures eat positive, "life-giving" magic, and psionivorous creatures eat psionic or emotional energy. Many magivorous creatures subsist on a mixture of arcane and divine magic, while the great magivorous predators digest every type.

Though the inner workings of magic are more thoroughly discussed later in this chapter, we must say a few words here. Magivorous predators are rarely purely magivorous. Magic isn't nearly as strong a source of energy as sunlight, but it has its advantages. Compared to sunlight, magic is more uniformly spread throughout an entire planet (inside and out), and it provides a very important source of energy in places where scarce sunlight or rain prevents mundane life. For large predator, surviving only on magic is more difficult than surviving on traditional energy sources, although ley lines may provide significant energy sources for even the largest creatures.

Plays Well with Others

Individual behavior varies wildly depending upon species, but the interactions between organisms share a lot of common ground. The primary rule obeyed by almost every creature is, "If it's bigger than you, avoid it." This applies to all types of animals throughout all the various life roles. With only a few exceptions, herbivore, predator, and detritivores all shy away from bigger creatures because things bigger than you generally possess a greater threat simply due to their size. This primary rule often extends to things of the same size, for even then caution is a worthy trait. Animals



tend to use caution when dealing with multiple creatures. Several creatures of the same type working together triggers the warning alarm for many creatures. Many predators work in pack groups, and every creature moves out of the way when a herd of herbivores stomps through. Most creatures (even predators) do not attack under these circumstances unless they feel threatened or if they have young. The protection instinct is very strong.

Succession

After a devastating war, grassy and non-woody plants seize the abandoned cropland. It is followed by small shrubby growth, and then full-sized trees. Along with the changing plants are their associated insects and animals. When a giant tree falls in the forest, plants quickly claim the sunny plot of ground, prime real estate in the plant world. As glaciers retreat and leave available unclaimed land, weeds and scrubs take root while animals follow their preferred primary producers. The replacement of one community of species with another over time is called succession, and succession is constantly occurring.

Succession is an interesting study. Take the fallen tree in the forest from above. When it falls, say from a windstorm, it is a ready source of shelter and nutrients. The first to exploit it is the bark and wood-boring insects that feed upon the inner bark and cambium. This results in a lot of the bark falling off. Within the wood, beetles or ants dig tunnels and gouge chambers to support their mushroom farms. The wood becomes moister as decay proceeds, though the most accessible nutrients are already depleted, leaving harder stuff behind. Fungi take over because they possess more complex





cellulose-breaking enzymes. As fungi break down the wood more, plant seedlings take root on the fallen tree. Their roots dig down into the tree, and through these paths they carry more fungus into the heartwood. Eventually the tree's broken down to soft blocky pieces. At this point, the greatest number of species uses it as food and as shelter. Finally, the tree's nothing more than a red-brown, mulch-like substance incorporated into the soil. More than likely, a seed from a nearby tree has already grown into a little sapling from which (with time and luck) a replacement tree grows.

While succession often happens on larger scales, such as areas covered with lava after volcanic eruptions, focusing on a single tree shows the majority of the processes involved even on the larger scale. Generally triggered by a drastic change in the environment (like cleared forests, exposed land from glacial retreats, and hardened lava), areas undergoing succession have large concentrations of specific species dispersed throughout the area. Some species eat and reproduce rampantly, taking advantage of the available resources. Many of these opportunistic species behave in such a manner because once succession areas mature, the majority of their population dies to competition and competitors with better fitness. On the other hand, only a few must survive to take advantage of another succession zone, leap-frogging from one suitable area to another. For example, weeds and grasses are the first things that sprout after a catastrophic ecological event and nigh impossible to completely eradicate once they've taken root.

The Inner Workings of Magic

The following information, as I'm certain your gnome has told you already, isn't for the eyes or ears of mortals. I'm certain you've heard the old saying, "Nature abhors a vacuum." Well that's not true; most of nature is a vacuum. What nature really abhors is the truth. You won't be able to find it anywhere, and if you do, best be prepared for the consequences. But enough with the cryptic mutterings...

Magic is a sentient creature. Like I mentioned earlier, the multiverse can be viewed as a parasite upon the body magic. More accurately, most gods of magic believe the multiverse has a non-obligatory mutualistic relationship with the body magic. They speculate that both could survive without the other, but association with each other increase their fitness: magic without the multiverse would be even more chaotic, while the multiverse without magic would eventually achieve a state of completely even heat distribution.

Unsurprisingly, magic on a planetary scale is a complex thing. Magic works very similarly to water in that it flows along the path of least resistance. It pools anywhere, regardless of depth, height, or pressure. Unlike water, magic doesn't usually pool in vast quantities. It is rare to find a magic pool any bigger than a large pond. A magic "stream" is called a ley line, and a magic "pond" is called a terminus. There isn't any relationship between the amount of magic flowing into a terminus and the size of a terminus; some of the most powerful ley lines have small termini while weak ley lines may have large ones. Ley lines are also unusually straight compared to most water streams. Most ley lines are divinely aligned, and most termini are arcanelly aligned, though some ley lines and termini are aligned to both.

Unfortunately for many mages, magic is a subtle energy, and magical topography is characteristically more so. Magical topography takes no consideration of physical situation, and it changes with incredible speed in comparison to physical topography. There is no relationship between physical topography and subtle topography (what spell casters call the magical topography). Subtle topography, as best explained to me, is a giant system of tunnels permeating the entirety of a world, completely unaffected by physical matter. I think of these tunnels as veins and arteries in three dimensions with tiny little capillaries filling the entirety of the remaining space.

Cycles

Everything must cycle; this is an integral function of the multiverse. Every part of a new world must also cycle: water, air, food, energy, tectonics, and even magic. Although infinitely more complex than any cycle that's limited to a single planet, magic's cycle extends throughout the multiverse as a whole. Some places have massive concentration levels while others are practically devoid of all magic. Whenever we create something, we must place our new creation somewhere in a cycle, whether it is a new cycle all together or part of a preexisting one. When placing living organisms in your world, diversity is the key to survival; create many independent steps and possible paths to complete the cycle.

My initial world concept was a flat world more like my homeland, rather than the rotund base planet. Each cycle starts and ends at an elemental plane. Thus water that falls off the end of the world heads back into the elemental plane of water, while more water is created from the same source at the center of the world. Tectonics function in the same manner; surface materials are added not by heat convection from the depths of the planet, but from the elemental plane of earth. It also returns there at subduction zones. Such could be done with all of the elemental planes.

Although this is a workable idea for any planet, my gnome informed me that it's a little beyond what we're expected to create for the council. He wouldn't go into to much detail, but he intimated that elemental-based generative and destructive forces require a finer sense of balance than the cycles of our base planet. This is understandable, given the need for massive planar gates. One also has to consider the effects of the distributed material on the elemental planes themselves.

Magic Flows: Ley Lines and Termini

Magic flows exist throughout every world. Some worlds are so poor in magic that only a few, weak flows exist, but the average world has hundreds, even thousands, of flows differing in magnitude. There are several basic types of flows classified according to what the ley line does and what affect the terminus has. All magic flows follow the lay of the subtle topography.

All magic flows along the general orientation of the ley line, but ley lines don't remain fixed in one area for very long. In this matter they're similar to rivers, but at a vastly increased period of change. These changes are, however, somewhat predicible. Each magic flow has a particular "flood plain" along which it moves. Most flows oscillate in a 10 to 40 year period, moving five feet in a single direction over the period of a single year. Spellcasters hoping to capitalize on a magic flow usually build strongholds that span the entire flood plain area of the ley line. For example, consider a powerful flow traveling north south for ten miles. Every year it moves 5 feet to the west or the east, and every fifteen years it returns to its original seat. The flood plain for this flow moves approximately 75ft, and its period (the length of time from the center, extreme west, extreme east, and then back to the center point) is 30 years. Ley lines also vary in width from year to year. This change is more unpredictable than the ley line's period, but any ley line rarely increases more than double or decreased more than half of its original size. The dynamic width of the ley line alters the size of its flood plain.

The most common magic flow is the magic-rich ley line with a magic-rich terminus. Magic richness increases casting capabilities, but sometimes it comes at a cost. The second most common flow is a magic-rich ley line ending in a terminus that is an elemental portal. The third most common is a magic-rich ley line feeding a null terminus, and the fourth most common type of magic flow is a null ley line feeding into a null terminus. The least common of the classifiable flows is a null ley line feeding into a multidimensional portal. These five flows make up over 90% of all flows in most magical worlds. The remaining flows are almost always unique and have so far defied easy classification.





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Magic-rich ley lines flow like life-giving rivers in the desert. Some ley lines are small affairs narrow enough for a running halfling to breach, but most are a decent size. Just like a real river, their effects reach out farther than their width, as concentrated magic seeps into the surrounding air, soil, and rock. Some ley lines intensify any spell cast within their area of effect, and some are powerful enough to damage anyone foolish enough to cast within their range of effect. Magic-rich termini have similar effects, just a different shape.

Magic-rich ley lines feeding elemental portal termini have slightly different characteristics; they tend to favor a particular type of magic as indicated by their portal. They intensify aligned magic while diminishing the opposite element. Some elemental portals are linked to the positive and negative energy sources as well. These two types of elemental portals are the most rare, but also most powerful. Negative portals are the source of many undead while positive portals are often holy sites. Of all magic flows ending in an elemental terminus, only 10% of those end in negative or positive portals. Most elemental gates are only medium-sized or smaller, though some are much larger. Negative and positive termini don't have actual gates (this would result in a massive energy release as the pure positive or pure negative energy touches matter), rather places where the shells between the planes are thinner.

Magic-rich ley lines also feed into null termini. These magic flows are hard to understand, but the gods of magic explain that most null termini aren't really devoid of magic, per se. Over 90% of null termini are actually magic-rich termini with an overabundance of microscopic magiotrophs, happily eating a vast percentage of the magic in the terminus. One would think that this would lead to a great population crash, but it appears most microscopic magiotrophs self-regulate their population to such a degree that the population is almost completely stable. In other words, just the right amount of magic comes out to feed all the magiotrophs, and there's nothing left to manipulate.

These magic-rich but effectively null magic termini often have massive amounts of vegetation and/or creatures tapping into the abnormally high numbers of magiotrophs in the area. Magical energy feeding the magiotrophs pump large amounts of additional energy to the ecosystem, which attract more exploiters. Magic-rich null termini are very similar to oases in comparison to regular terrain. However, don't try to cast any spells, they won't work. I wouldn't spend too much time there either, unless you're willing to have your mind slowly stripped of its ability to manipulate magic. Some null termini are simply places low in magic. The gods of magic believe these are magical sinks where magic quickly drains elsewhere, leaving behind an area of null magic. Beware of these places as well if you use magic.

Null ley lines feeding into null termini share some characteristics with the above magic flow. Some are places where magiotrophs feed in fast numbers, and these flows teem with subsequent flourishing of life, but the majority are magical sinks. Sinks are places where magic is being shunt elsewhere usually via a time manipulation done by the body magic. I don't understand the particulars (although my gnome was pleased to explain them to me – at length), but the particulars aren't important to the broad scale at this point. For what it's worth, the magic isn't "missing" at these sinks; it's simply "somewhere else right now."

The last of the common magic flows are null ley lines that feed into multidimensional portals. These compose only a small percentage of all magic flows, and powerful creatures usually guard them jealously. The portal is typically large-sized and often bigger. The gods believe null ley lines feeding into portals power the connection between two planes. Were the null ley line cease to connect with the portal, the portal would cease to exist. A very few (0.1%) of these portals can be controlled and ordered to link to any plane their master wishes. Needless to say, you had best be prepared if you plan on owning or controlling one of these magic flows.

The remaining 10% of magic flows are non-classifiable as they are, in essence, unique to their environment. This means that out of the thousand or so magic flows on any magical planet, around one hundred will be different than the five types listed above. I recommend the library to give you additional ideas about these magic flows.

Magical Metabolisms

Magic on a planetary scale affects every creature's diet and behavior. Almost every living organism on magical planets possesses some manner of magical or magically-aided digestion. This is not unusual as everything in a creature's environment exerts influence upon the creature. It also presents us with a very useful classification system: creatures that can exist without magic and those that cannot. Some creatures live almost exclusively on traditional sources of energy, but still require the digestion of magic for survival. Some merely require magic and die of starvation when deprived of adequate magic. Others are unable to perform some magical act through which they captured their prey. Every organism that requires magic for its survival is termed magically dependent.

Magic is a force that fuels life. Magiotrophs "eat" magic and turn it into physical tissue, but this tissue is not the same as non-magically formed tissue. Tissue created through photosynthesis and chemosynthesis leaves no trace of its origin. Magical tissue, however, retains the same amount of magic is spent in tissue creation. This is what the gods of magic call the law of conservation of magic. Magic can never really be "digested," it is merely used in one form or another. This magically infused tissue travels up the food web, becoming more concentrated at higher trophic levels. By the time an apex predator eats magically infused tissue, the tissue itself almost detects as magic.

Magically dependent creatures use ambient magic in their food to fuel their supernatural abilities or to support a physical structure that is counter to the laws of physics. Without the presence of magic in their food, they would die; storm giants are a good example. The typical storm giant is either a hunter/gatherer or an agriculturalist. The staple of their diet is magic-heavy vegetation farmed from any number of wild highly magical fungi. With hunting, they supplement their diet with top-level predators, who have the most concentrated magic in their tissue. The magic they consume from these two sources supports their physically impossible size and frame while powering their supernatural abilities and spell-like abilities. Storm giants can live on low-magic foods like bread and cheese, but given enough time they develop physical problems from magic deficiency. Without ingesting magic through their food, they perish from magic starvation, just like humans do when they don't get their required nutrition from their food. Many creatures survive in a state of magical starvation for a long time, but other creatures may not hold out for long. Each organism has a different metabolism which influences how long they can go without eating food containing enough magic to stave off physical difficulties.

Every creature has an optimum level of ambient magic in the food they eat, and every creature possesses a minimum magical intake requirement as well as a maximum intake. Maximum intakes are the level at which a creature cannot safely digest any more magic from that piece of food. Similar to mundane nutrients, every creature's digestive system can only extract so much energy from a particular piece of food. Though these levels vary from creature and foods, there is only so much benefit creatures can extract from ambient magic in their food. Ambient magic in tissue may exceed a creature's maximum intake, effectively poisoning the consumer. In this way, magic can be treated like a dangerous substance. Most of the time creatures don't notice that they've eaten a piece of food that's slightly more magical than they can handle because it's only a little more than their tolerance. However, if the amount of magic is great enough, such food



can sicken creatures upon consumption. Some tissues are so magical that they kill their imbiber if their consumer can't assimilate the magic. Magic gives life, but it also takes it away.

An interesting side effect of ambient magic consumption is the change in the consumer. Along with evolution, this is the primary mover in the creation of new species. Once a creature consumes just slightly more magic than he should, that magic works a slow change in his basic structure that is passed along to his children. In this manner, all sorts of creatures evolve, and this process may expedite natural processes to increase variety and speciation. Upon reflection, this makes perfect sense. The body magic and the multiverse are mutualistically bound, nature's evolution must have its appropriate magical counterpart: a type of magical evolution. Magical evolution and magical adaption play important roles in the creation and maintenance of more "monstrous" species.

Magical Ecosystems

The most common magiovorous creatures are the microscopic magiotrophs. These tiny creatures only eat magical energy and turn it into organic matter. Unlike photosynthetic or chemosynthetic creatures, magiotrophs only require magical energy for this process and nothing else; no water, no nutrients, no oxygen, nothing but magical energy. This powerful ability makes life viable in places that traditionally cannot tolerate life, and it creates the unique monstrous creatures so prevalent upon magical worlds. But before we can talk about dragons, we must spend considerable time discussing the lesser life forms that provide the dragon his sustenance. We must discuss the magical plants, fungi, insects, and lesser creatures that create the base of the pyramid upon which the dragon feasts.

But even now I'm jumping ahead of myself. Before discussing any of this I need to explain the different ways in which magic passes through ecosystems. Magical energy in every ecosystem manifests primarily in two ways. The first is the bounty method. In bounty use, the ecosystem transfers its magical energy into primary producers, turning the worst non-magical desert vegetation into more of a desert/very dry grassland mix. The bounty method utilizes magic as a force that combats the limiting factors of the environment (water, soil, sunlight). The other method is the concentration method. These ecosystems transfer their magical energy into supporting tougher life without increasing overall vegetative production. In these systems, plants act like magical sponges that soak up the ambient magic but don't use it to increase their species overall growth and proliferation like in the bounty method. Instead, they hoard it to provide unique survival traits (mobility, magic use) and to prevent other creatures from utilizing the ambient magic. In other words, plants grab as much magic as they can because if they don't, something else will, and that likely leads to decreased fitness on the plants part. Most ecosystems are mixes of both the bounty and the concentration methods, but both harsh and lush climates tend to favor the concentration method over the bounty method.

Back to the base of magical ecosystems, microscopic magiotrophs eat magical energy and turn it into organic matter. There are three types of microscopic magiotrophs. Some are independent creatures, like other microscopic organisms, but most have symbiotic relations with some host creature. These symbiotic relations often develop into obligatory relationships (hence, the numerous magically dependent creatures), but many are non-obligatory. Microscopic magiotrophs are most often found in the digestive systems of animals or in the root systems of plants. In plants, these small creatures turn magical energy into required nutrients (basically mimicking photosynthesis) while in animal guts the magiotrophs are themselves consumed after turning digested magic into organic matter. A delicate microscopic magiotrophic balance is maintained throughout the digestive system just like the more traditional



microbial balance. It must be stressed: magic itself is transformed and stored within the recipient creature, be that plant or animal. Creatures use this magic to fuel their supernatural and spell-like abilities.

Once we pass the microscopic stage there are several magical fungi that feature prominently in the magical food chain. These fungi exist on magic just like regular fungi exist on detrital material. Their fruiting bodies (the mushroom part) are primary food items for underground dwellers. A few of these magic mushrooms provide powers to their imbibers, but most are simple food items. Some of the largest mushrooms act as a sort of underground wood while others convert magic into oxygen or other gases both beneficial and detrimental. Although you would not suspect it, dwarves are loving caretakers for their fungal gardens, feeding them only the best stone dust, dried potions, and ground magic items or metals.

Magical plants shouldn't be a strange to you. They're the staple of every magical planet and can be found in every biome. Trying to cull their diversity into a single paragraph seems a hopeless endeavor, but remember that magical plants can occupy any location in food webs; some are producers, others are top predators. Magic provides these organisms with movement and often with intelligence. This added to their vegetative prowess is a fearsome combination. Magical plants are often hardier than their animal counterparts, able to withstand long periods of drought or starvation.

Just because magical plants are hardy, don't think that they're immune to what their ecosystem can throw at them. Magical insects (vermin, to be more precise) are some of the most dangerous creatures on any magical planet. Their sheer numbers, efficiency and often-militaristic social orders make them worthy of consideration. Although most magical vermin are fairly innocuous and fill a niche much like their non-magical brethren, those few that are not innocuous can be truly terrifying. Just ask any villager who's witnessed giant army ants on the march or who's fallen prey to highly aggressive magic-using wasps. Everyone knows magic has its greatest effect upon the animal kingdom. It is here that most monsters dwell, and the maddest, strangest things curse the world.



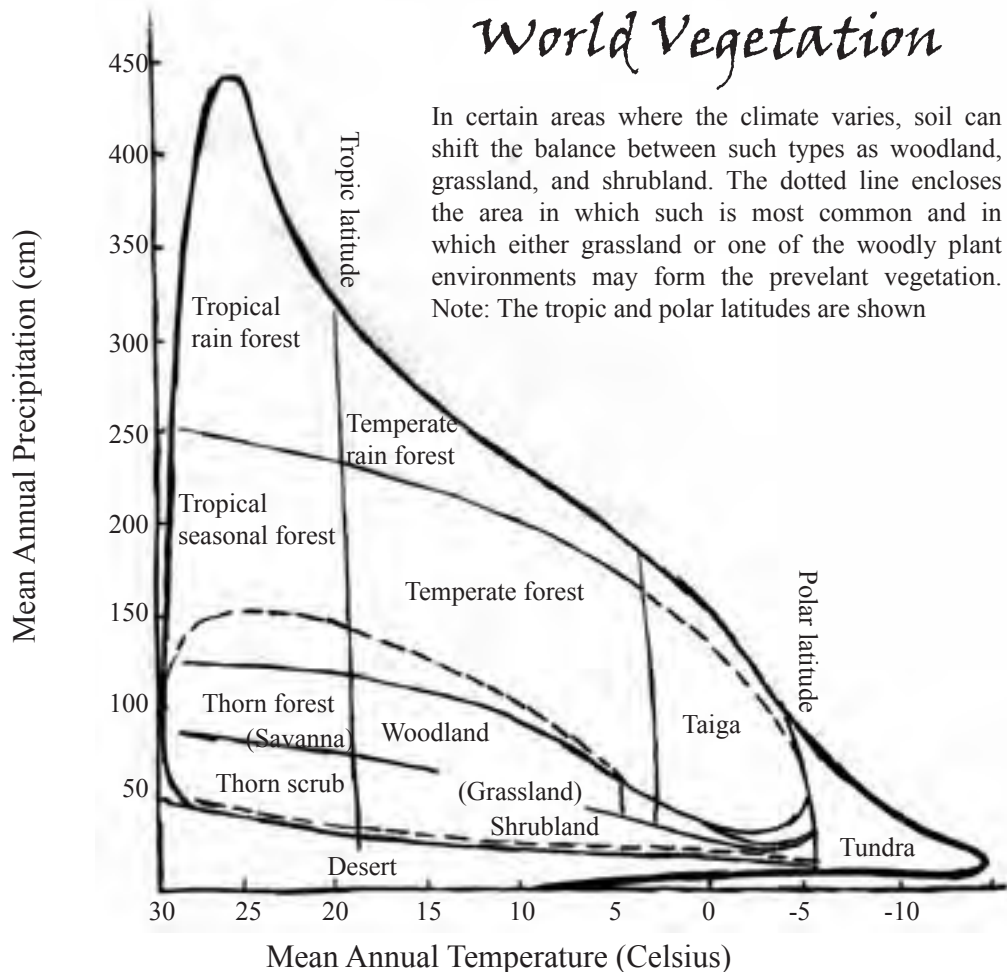
Biomes

Every location on the planet has an associated temperature, rainfall, plant life, and animal life. These associated units are commonly called biomes. Each biome consists of a distinctive combination of plants and animals characterized by a uniform type of vegetation, like grassland or coniferous tress. Each biome shares borders with other biomes. Along these borders the vegetation and animal life exists in differing gradients from one biome to another. These gradients along biomes are called ecoclines.

In addition to these localized changes, there are gradual changes in other ecosystem characteristics brought upon mostly by latitudinal change. There is a general decrease in species diversity, productivity and the general amount of organic matter the further north and south of the equator you travel. There is also a corresponding decrease in the complexity of ecosystems, in the size of plants, and in the amount of vertical plant stratification. Growth forms also change (tropical rain forests are dominated by phanerophytes and epiphytes while artic the tundra by hemicryptophytes, geophytes, and therophytes) and wherever there's a similar environment, similar types of creatures are present. Although species vary greatly, communities tend to have similar physiognomy, showing convergent evolution in action.



World Vegetation



Tundra and Taiga

Tundra and Taiga are two biomes common to cold polar regions and to certain bands along mountains. Tundra is the treeless plain near the poles or the tops of tall mountains while Taiga is the large belt of coniferous forest enclosing the tundra. Although they are unique biomes, they almost always occur side-by-side: where one is found, the other is often next door.

Tundra is a treeless plain covered with heath, sedge, mosses, rushes, and herbs. Low temperatures, low precipitation, and a short growing season characterize tundra. Full of lakes and streams, tundra also has extensive bogs when the land is low in relation to its surrounding terrain. On high areas or areas exposed to the brutal wind, the ground is mostly bare rock with a scattering of vegetation. The rocks are usually lichen covered, giving a deceptively green color to an inhospitable place. As mentioned above, there are two types of tundra, that around the poles (called arctic) and that around mountains (called alpine.)

Much of the arctic tundra is the result of permafrost's actions. Permafrost is the perennially frozen subsurface that can run hundreds of yards deep. Below the thin layer of soil melted by the summer's heat, a massive piece of permanently frozen earth awaits. Because the permafrost is impervious to water, it forces all water to remain above it. This creates a wet, marshy environment allowing plants to survive even though most of the tundra experiences yearly precipitation levels equal to deserts. Unlike most deserts, there is very little evaporation (the air is too cold to hold much water) so life has ample water. There are places called polar deserts where almost no moisture exists, and in fact, the driest place on our base planet is Wright's Valley in Antarctica.

The alternating yearly freezing and thawing makes for some unusual and seemingly magical patterned landforms. As the permafrost forces all water above itself and the water freezes, stones and other debris are forced up from the mass of the permafrost. This forms frost boils, earth stripes, and the most well known of all tundra landforms, stone polygons. Year after year, decade after decade of freezing and thawing push the rocks and debris together, forming a hex map across the land. Creatures arriving on these plains for the first time are bound to be amazed and wonder what type of being created them.

Alpine tundras have very little permafrost and that is mostly at very high elevations. Alpine tundra is not usually as wet as arctic tundra because the steeper topography allows the thawed water to flow down the mountainside instead of staying on the surface. In some elevated valleys, alpine tundra bogs may form, but these are uncommon. Alpine tundras don't have many of the patterned landforms for the same reason, and even though precipitation is higher, alpine tundras are dryer.

Tundra vegetation is simple, and there are only a few species. The growth is slow, and most of the functional aspects of the biome are confined to a few groups. The arctic tundra is a harsh place with constant soil disturbances from the permafrost cycle while wind-borne particles of soil and ice batter any life strong enough to take root. Alpine tundra is even harsher, as winds are very strong near the tops of mountains, and temperatures fluctuate even more wildly than in arctic tundra. Plants are short by necessity, allowing them to reduce the amount of heat they lose from wind chill.

The most common arctic vegetation in boggy ground is cotton grass, sedge, dwarf heath, and sphagnum moss. In well-drained arctic tundra, you may find heath shrubs, dwarf willows and birches while crustose and foliose lichens grow on rocks on dry and exposed sites. Alpine foliage is similar but mat-forming plants are more important because they can withstand the constant buffeting wind. Under the mat-forming plants is a small, cushioned area with air that can be 65° warmer than the surrounding air, creating a microclimate favorable to insects.



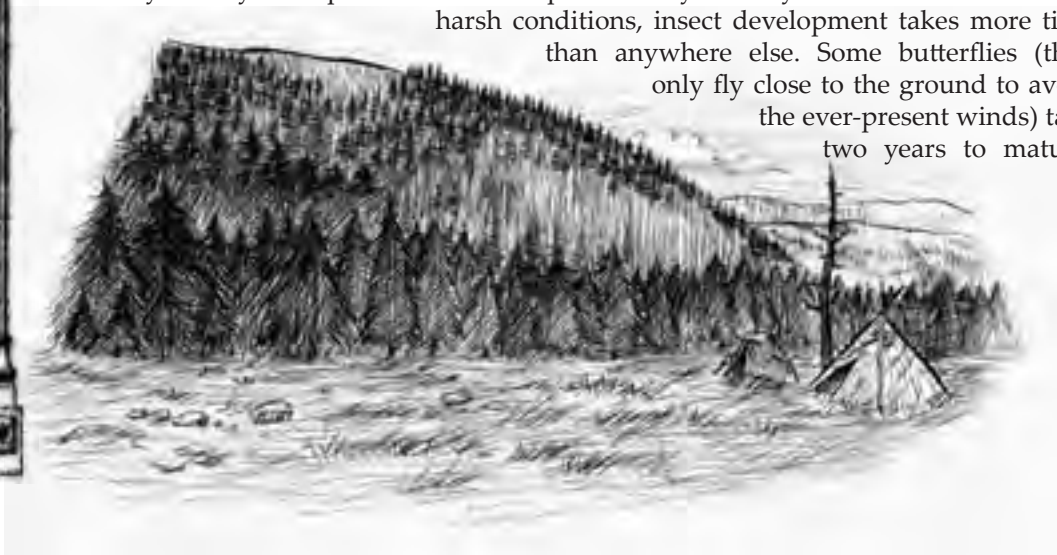
Alpine tundra in the tropics is a very unique environment. Tropical alpine regions undergo great seasonal variation in rainfall and cloud cover (often from monsoon action) but experience little seasonal variation in average daily temperature. Instead of the seasonal variations, alpine tundra experiences daily variation on a spectacular scale: below freezing at night to hot, summer-like temperatures during the day. Since cold is not of a seasonal duration, plants can grow taller. Tropical alpine tundra sports giant, treelike rosette plants that resist the nightly freezing temperatures. Also, unlike every other type of alpine tundra, these plants get larger (over 18 feet) the higher up you go. These plants are rather unusual as they retain their dead leaves around their stem to reduce heat loss, secrete a mucilaginous fluid about the bases of leaves which functions as a heat-storage device, and possess dense pubescent hairs that reduce convective loss of heat. They're well adapted to their dramatic environment.

Almost all arctic tundra plants are non-seeding (reproducing through vegetative means), but what seeds do fall can remain viable for hundreds of years. Alpine tundra plants are mostly seed propagated. Both environments' topography plays important roles in density of vegetation. On arctic tundra, steep slopes facing the equator and river bottoms support the most luxurious shrubs, grasses, and legumes (although arctic luxury is still slim) while gentle slopes are dominated by cotton grass. Alpine tundra is thickest along the equatorial facing slopes (more light hits those slopes) and along drainage runs.

Primary production on the tundra is very low in comparison to other biomes. Low temperatures, a short growing season (50-60 days in the high arctic up to 160 days in low alpine tundra areas), and poor soil nutrient content all conspire to make it difficult for plants to thrive. Plants can only be photosynthetically active on the arctic tundra for roughly three months out of every year. Once snow cover lifts, plants start photosynthesis even though it isn't terribly effective due to poor leaf development. The plants quickly correct this by using stored energy in their roots and rhizomes to quickly boost leaf production. Plants continue to photosynthesize up to about a month before the return of the snow. All energy is then redirected into root and rhizome production to ensure enough energy for next year. Alpine tundras are generally more productive than arctic tundras, but both types' plants sequester up to ten times the amount of energy in their roots for winter than temperate grassland plants. Hence, the potato.

Tundra animals are also a tough lot. They have some of the most inhospitable environments on any planet with which to contend. But once winter's grip ends, life springs forth in surprising amounts. Starting from the bottom and going up, insects are plentiful in arctic tundra during the summer. So many in fact they sometimes darken the sky as they rise up in swarms. This process may take a year or two because in the

harsh conditions, insect development takes more time than anywhere else. Some butterflies (they only fly close to the ground to avoid the ever-present winds) take two years to mature,



while grasshoppers take up to three. If you ever go to the tundra during summer, prepare to be slowly eaten alive by mosquitoes. So numerous are they that every year some caribou are driven mad and effectively persecuted to death. I've known few men tougher than reindeer, so prepare for them if you travel on the tundra.

All of these insects provide excellent prey for birds. Sandpipers, plovers, longspurs, and some waterfowl all enjoy a veritable smorgasbord of insects during summer nesting. Along with birds, shrews make an impact into the insect population, gorging themselves while they have the chance. Meanwhile, lemmings, voles, squirrels, pikas, and hares are busily gobbling as much foliage as they can while trying to avoid ermines, weasels, foxes, minks, bears, lynx, wolves, wolverines, and predatory birds. But the larger predators are more interested in moose, caribou, snow sheep, and the rare muskox. The arctic tundra explodes with activity when the cold is finally gone.

Magic adds increased complexity into tundra biomes. Tundra organisms maximize all energy from non-solar sources. Of all biomes, tundras are only equaled by deserts and outshone by underground biomes when it comes to the drastic changes from ambient magic. On most magical planets, magic provides as much energy as the sun on the tundra, and unlike the sun, magical energy is equally distributed throughout the year. As much magic energy is available during the coldest winter months as there is in the height of summer. This magic energy increases the overall diversity on a magical planet beyond what is found on our base planet. Microscopic magiotrophs turn the energy into tissue, and magic moves up the food web through predation, providing a dependable year-round food source and supporting a higher biomass.

Arctic druids will tell you that the tundra is a vicious killer if you don't know what you're doing. And they're right. But they won't always tell you how fragile the tundra's ecology is and how easy it is to disrupt. Since conditions are so harsh, disturbances often result in almost permanent destruction. Something as simple as digging a grave can destroy the life around the site. Not that you'd succeed in making a decent grave; anything you put down is eventually pushed up by the permafrost cycle. Use a bunch of rocks instead.

Taiga (boreal forest) is the largest vegetation formation on our base planet. It covers roughly 11% of the terrestrial surface in a large coniferous belt in the high latitudes. Its northern limit is the southern limit of tundra, but its southern limit is much less distinct. In some places, taiga becomes colder grasslands after a short layer of mixed forest. In other areas, taiga loses ground to deciduous trees in the slow switch toward full-sized mixed forest. Taiga often stretches shore to shore on the largest of continents. Although it's not as harsh as tundra, it is still a fierce environment unfriendly to easy settlement and taming.

Taiga is composed of four vegetation zones: the tundra-forest ectone with open stands of stunted spruce, lichens, and moss; the open boreal woodland with stands of black spruce and lichens; the main forest mainly populated by pines and spruce with breaks of birch and poplars in disturbed (succession) areas; and the mixed-boreal forest ectone where the boreal forest begins to turn into the mixed forests of lower latitudes. Taiga is dominated by spruce, pine, birch, and larch.

Summers are short, cool, and moist while winters are long, harsh, and dry with long-lasting snow. Although not as unbearable as tundra, taiga is far from welcoming. Seasonal temperature differences are the most extreme in deeply inland parts of the taiga and can vary over 200°F. Even with warmer temperatures, little light hits the ground because of the dense canopy. This means permafrost still exists under much of the taiga and just like the tundra. Permafrost has a chilling effect upon growth potential of the taiga. It reduces soil depth and impedes infiltration. By deterring drainage, it creates high soil moisture while slowing natural decomposition and reducing vital nutrients to the soil (like nitrogen). But the permafrost's detrimental effects are ironically increased because of the trees of the taiga themselves. Since the trees are so





thick, the lack of light under the canopy only allows certain plants to flourish. Thick carpets of mosses grow in the dim light under the spruces and firs while lichens thickly grow under the pines where there is slightly more light. This vegetation (along with the layer of undecomposed needles) acts as an insulator to the permafrost. The colder the soil becomes, the more the permafrost moves towards the surface, and the less soil is available to tree roots. During periods of early warm weather, the roots are still encased in the permafrost, but the tree is losing water through its leaves. This leads to "winter kill" where a tree dehydrates while standing in moist soil because its roots are still encased in ice and can't replenish its water needs.

One very beneficial event in the taiga is fire. Fires occur on a fairly regular basis and sweep over hundreds of thousands of acres in periods of drought. All of the trees are well adapted to fire, and unless it is too severe, fire provides a seedbed for the regeneration of trees. Successional hardwoods favor light burns while more severe fires eliminate hardwoods, favoring spruce and pine regeneration. Fires also release various accumulated nutrients, but more importantly, it improves the conditions for decomposition by warming the soil and exposing organic material to sunlight.

Taiga animal life is more diverse than on the tundra although many species share both habitats. Caribou inhabit the more northerly portion of the taiga, and their yearly migrations often lead them off the tundra to find shelter in the trees. They feed off the grasses and sedges growing in the forest-tundra ecotone, and they're especially fond of the lichens living under pines. Moose, the largest of all deer, calls the taiga its home. Also known as elk, it feeds off aquatic and emergent vegetation as well as the alder and willow. Arboreal red squirrels inhabit the conifers and feed on the seeds of spruce and fir along with male flower buds while the prickly porcupine busily feeds on leaves, bark and twigs. Also feeding on tree bark is the dam-building beaver. Deer are found here in the greatest diversity (more species of deer than any other biome), and the bird population is healthy (nutcrackers, woodpeckers, and finches) feeding on seeds, cones, and insects. Many of the bird species migrate south during the harsh winter, however. There are few reptiles or amphibians (it's too cold in the winter), but the few present give live birth because there's too little sun to properly warm eggs. Insect life is far richer in the taiga than on the tundra. Major predators include the wolf (feeding on snowshoe hares and other small mammals), the pine marten (the major predator of red squirrels), several other species of weasels, as well as bears, wolves, and lynx.

Taiga animals are clothed in thick, insulating coats of fur or feathers, which are especially luxurious in winter. Many of the animals are also particularly larger than their cousins in kinder climates. This burly size is an advantage because the larger the animal, the smaller its surface area to body mass ratio, which reduces its overall heat loss. The moose (the largest deer), the wolverine (the largest weasel), and the capercaillie (the largest grouse) all make taiga their homes. The cold has also created some of the most valuable pelts in the world on the animals of the taiga: mink, marten, ermine, and beaver.

Grasslands

Grasslands claim 23% of all the land not covered by ice on Earth, and they are grouped into the temperate grasslands (steppe and prairie) and tropical grasslands (savanna). The main difference between the three grassland types is temperature. Steppes are coldest, and savannas are warmest. This creates a different set of species that can survive in each different environment.

Steppes and prairies receive little rain. Anywhere from 8.5-30 inches of rainfall in a single year, these grasslands barely receive too much to qualify for a wet desert and not enough for a forest. Savannas receive more rain (19-78 inches a year), but their rain falls on poorer soil and in extremely variable amounts (60-90% of the rain falls in a single period or in two distinct periods). Grasslands also have a high rate of



evaporation, periodic drought (with periodic severe droughts not being uncommon), a flat or rolling terrain, and animal life dominated by grazers and burrowers. One unusual aspect of grassland is its need for periodic fires for maintenance, renewal, and eliminating encroaching woody plants in the wetter grasslands.

Grasses have adapted to both grazing and fire. Grassy plants consist of leafy shoots called tillers. Each tiller has a leafy blade and a tube-like base growing from short, stem-bearing root nodes. These nodes only grow upward when the plant begins flowering. These grasses are termed bunch or tussock grasses because they grow in bunches across the plains. The grasses that spread through lateral buds on underground stems are called sod or turf grasses. Drier grasslands favor tussock grasses while wet grasslands favors turf grasses. Ironically, both grazing and fire spur vigorous growth from grasses. Grasses wait safely underground, and when the vegetation above ground is destroyed, the belowground vegetation sprouts anew with energy stored in roots. Grasses expend their stored energy quickly to ensure their survival.

Steppe grasslands are the coldest of grasslands and spend around 3 months per year with average temperatures around freezing. The grasses here are all short, hugging the ground like the vegetation of the tundra. Tussock grasses are typically favored over turf grasses, but this depends more on rainfall than temperature. Fescues, feather grass, and daisies dominate the landscape.

There are three types of prairies: tallgrass, mixed-grass, and shortgrass. Tallgrass prairies are well developed in areas that could support forests, but through fire and strong competition, they maintain their hold on the land. The forests usually encroach into tallgrass prairies on hills, sandy areas and along streams and rivers. Big bluestem, goldenrods, compass plants, snakeroots, and bedstraw are the major turf grasses, while needlegrass, side-oats grama, dropseeds, and many different types of daisies are the main bunch-forming grasses. Shortgrass prairie occur where rainfall is infrequent and light. The shallow-rooted grasses maximize the moisture in the upper soil layer and don't have deeper penetrating roots. Sod-forming blue grama, buffalo grass, wheatgrass, side-oats gram, and little bluestem make up the majority of the grasses in shortgrass prairie. Sod is particularly dense in shortgrass prairies. Mixed-grass prairies





vary between the two others depending mostly on how much rain they receive in any particular year. In wetter years, they favor the tallgrasses while in drier years they favor shortgrass. As you'd expect, mixed-grass prairies are often between larger belts of tallgrass and shortgrass, acting as buffer zones wherein species are more or less successful based upon the year's rain.

Savannas are still very much grasslands, though they enjoy more rain per year than the other grasslands and more woody plants. The most conspicuous plants are flat-leaved grasses that grow as tall as five feet. Typically one or more grass species dominate a particular area and clump, but fairly regular spacing of trees round out the average savanna view. Most trees are short-lived (except for the impressively thick baobab), and detrital-processing termites are a conspicuous component of savanna life. Their mounds sometimes grow almost as tall as some of the small trees. Savannas are hot year-round possessing average monthly temperatures rarely lower than 68° during the coldest months. Of all the grasslands, savanna is the most dependent upon fires. Without them, dense woodlands would quickly overrun the savanna.

There is another type of grassland, slightly less natural than the others. Hayfields and pasturelands are vast amounts of grassland created through the work of intelligent species. Most of these grasslands are recovered forestlands, cleared for settlements and agriculture. When left without intelligent care, these grasslands quickly revert back to forests, but some develop climax vegetation that resists reverting since they have been under the care of intelligent species for hundreds of years.

Animal life on the grasslands is diverse and healthy. As in all biomes, insects are ever-present: ants, spiders, beetles, grasshoppers and many other species are found in the grasslands. Termites are especially important on savannas. Personally, my favorite insect is the dung beetle. This little creature collects poop, rolls it into a ball (sometimes as large as an apple), buries it, feeds on it, and then lays its eggs in it. The young ones finish off the ball when they hatch. This inadvertently spreads seeds, spores, and nutrients. Burrowing creatures also form a basic block of the grassland's ecosystem: prairie dogs (whose burrows can stretch for hundreds of square miles), armadillos, meerkats, moles, springhares, gerbils, bobak marmots, sousliks, and common hamsters. An uncommon burrower is the burrowing owl, who claims deserted prairie dog burrows and uses them as nests. Another burrower, the rattlesnake, claims tunnels as well, but when the prairie dogs smell him out, they try to close up the tunnel in which it is hiding. The more aggressive meerkat have been known to chase snakes away through harassing techniques.

But the animals everyone is familiar with on the grasslands are the large grazers: bison, prong-horned antelope, zebra, wildebeest, giraffe, gazelle, elephant, rhino and wild horses. Many of these creatures are major grazers in almost all grassland, and in the case of the bison, they can roam in huge migratory herds numbering up to the millions. Grasslands that lack one or more of these species usually have a replacement species. Kangaroos, those long-distance hoppers, are marsupial replacements for the ungulates in some grassland. In dry grasslands, camels may make an appearance.

There's also a good chance your grassland has some species of giant bird, like ostriches, rheas, emus, or moas. These birds have lost the ability to fly but have great running speeds and a good strong defensive kick used against the larger grassland predators. Major predators include lions, leopards, cheetahs, hyenas, and wild dogs. There are also a great many scavengers like jackals and vultures. Most grassland predators are not above scavenging a fairly fresh kill as well.

Even with all the apparent life in the grassland, the massive herds of grazers, and the packs of predators, the majority of biomass lies beneath the soil in the form of nematodes. Aboveground herbivores only consume 2%-7% of primary product, while underground herbivores account for 13%-46%. The humble creatures have the greatest effect upon grasslands. On the savanna, termites play a very important role in breaking down plant litter and modifying soil properties. Mound-building termites move tons of soil into large defensive mounds, binding them together with saliva and excrement. Termites need their food partially pre-digested by mushrooms, so they build large fungus chambers underground and deep within the mound to ensure a moist environment. They then harvest the fungi, feeding them with dead vegetation, feces, and dead termites. The subsequent heated air leaves through the fluted top tunnels, replaced by cooler air from side tunnels that breach the surface. In a way, termite mounds breath.

Forests

Forests have long been one of the most useful biomes for intelligent life, providing wood for heat, buildings, and tools. There are three basic types of forest: coniferous forests (taiga/boreal forests, montane forests, pine forests, and temperate rain forests), broadleaf forests (deciduous forests and temperate evergreen forests), and tropical forests (rain forests, seasonal forests, and dry forests). The boreal forest has already been discussed under tundra and taiga above, so we'll focus on the remaining six.

Montane forests are coniferous forests in the mountains. Spruce, fir, mountain hemlock, pine, incense cedar, and the giant sequoia compose the majority of montane forests. As you can tell, montane forests share many characteristics with boreal forests, but permafrost doesn't have its icy grip on montane forests, except perhaps at their very highest elevations. Low-elevation montane forests are dominated by ponderosa pine and include the deciduous quaking aspen before eventually turning into pine forests. Pine forests consist mainly of pine trees, in particular, the scots pine. They occupy much of the colder temperate latitudes. In some places, pine forests turn into temperate deciduous forests without the without disturbance from fire. These pines keep their advantage over the deciduous by being better adapted to the fire regime. Pine forests also contain the valuable pitch (for fuel) and white (lumber) pines, the loblolly, longleaf, and slash pines.

Temperate rain forests are forested wonderlands created by mountains. When warm and wet air currents coming off an ocean meet a tall mountain range, they dump massive amounts of water onto the ground below. This usually occurs in tropical regions because few temperate air masses contain enough moisture on a continual basis. But, when this happens in temperate regions, a temperate rain forest occurs. The most familiar temperate rain forest is along the western coastline of North America where the Coast Range juts up. Temperate forests have milder climates than other areas at their same latitude, but still experience significant snowfall along with summer rain. Total precipitation is around 290 inches per year. Conifers dominate temperate rain forests: western hemlock, mountain hemlock, silver-fir, douglas-fir, and massive redwood trees. All of the trees are well adapted to wet mild winters, dry warm summers, and nutrient-poor soil.





Deciduous forests cover vast amounts of the temperate zone. Beech, oak, ash, birch, and magnolia all make deciduous forests their home. Deciduous forests often follow rivers deeply into grasslands, creating fingers of green among the grasses. There is tremendous variety among deciduous forests, and each displays their own unique characteristics depending upon what tree or tree group composes the majority of the forest. Temperate evergreen forests occupy the sub-tropical regions of the temperate zone. They straddle the line between temperate and tropical, often including mixes of both broadleaf trees and coniferous trees. Eucalyptus, paramo, anacardia gallery, and false beech forests are all temperate evergreen forests. Palm trees, oaks, gumbo-lumbo, and magnolias are often found in temperate evergreen forests.

Tropical rain forests are mostly restricted to the equatorial zone 10° N and 10° S latitude. This is the area of the planet where temperatures are warm year-round and almost daily rain falls in amounts that are measured in yards per year. Most tropical forests grow below 3,250 ft., except in situations where extremely strong wind patterns can push enough rain to higher elevations, and cannot grow in places that experience more than five months of dry season a year. There is so much vegetation within a tropical rain forest that it's hard to know where to begin describing. Lowland rain forests are very multi-layered; mountain forest have abundant undergrowth of tree ferns and palms; and cloud forests are continually wrapped in clouds and mist, covering their thickets and epiphyte laden trees. Fingers of rain forests called gallery forests follow river courses onto the savanna. There are over 1.5 million species of plants and animals in an average world's rainforest, and the rainforest's importance should not be overlooked.

Seasonal tropical forests are rain forests subject to periodic dry seasons. They share many of the same characteristics with rain forests, but their yearly two-to-four-month dry season causes around 30% of all the upper canopy trees to shed their leaves. These rain forests are fairly common in areas with a monsoon season, and the leaves come back either right before the monsoon begins or right after. Happily for the forest dwellers, fruiting usually occurs right before the dry season.

Dry tropical forests experience a prolonged dry period; the farther the forest is from the equator, the longer the dry period (up to eight months). During the dry season, the trees and shrubs drop their leaves and stand bare. Just before the rainy season, which can drop even more rain than in the wettest of the wet months for other tropical forests, the trees and shrubs burst back into foliage. The landscape is a uniform green color for this period. Much of the dry tropical forest consists of thorny trees.

Coniferous forests have poor vertical stratification in comparison to deciduous forests. Vertical stratification is the division of communities into distinguishable vertical layers throughout a forest. Some creatures prefer to live their life in the canopy, while

others spend the majority of their time near the ground. Coniferous forests have poor vertical stratification because most conifers in mature forests have the vast majority of their branches at the crown. The crowns of coniferous forests often get so thick that no other plants can easily survive on the forest floor. However, few species of conifers have thinner crown growth, allowing a grassy or shrubby understory.

Animal life in coniferous forests is varied and adapted to the generally colder climates. Insects are prevalent in numbers, but not so in species because of the homogeneity of many stands. This lack of insect diversity can lead to catastrophic infestations that devastate large tracks of the forest. Birds are plentiful; chickadees, finches, thrushes, tits, and grosbeaks are all common in coniferous forests. Most mammals are not confined to only coniferous forests (outside of the boreal, which has several exclusive species like the marten and lynx) and are commonly found in deciduous forests; deer, bear, mountain lions, and squirrels are common in coniferous forests.

Coniferous forests are often dependent upon mycorrhizae (the symbiotic association of the mycelium of a fungus and the roots of a seed plant) for healthy functioning. Dead trees also make up a very important part of the coniferous forest ecosystem. 10-20% of the forest floor is covered with fallen trees, providing food, protection, animal pathways, and reproductive sites for trees. In coniferous forests, life tends to be more concentrated around fallen trees.

Broadleaf forests possess well-developed vertical stratification. Normal, unevenly-aged forests have an upper canopy consisting of dominant and co-dominant trees, under which is the lower canopy, the shrub layer, and then the ground layer occupied by ferns, herbs, and mosses. This stratification breaks up in evenly-aged forests (due fire, or intensive logging) which only have a well-developed canopy with poorly developed layers underneath (except in open areas). Coverage in broadleaf forests allows little light to reach the ground; only about 6% of the midday sun reaches the forest floor. Within this dim forest, humidity is comparatively high from all the plant transpiration, but temperatures are much cooler.

Broadleaf forest animals depend upon this stratification. Some insects are horizon specific and cannot live outside of their adapted layer, but most focus on two layers outside of which they cannot survive. The greatest concentration of life in broadleaf forests occurs just above and just below ground. Many subterranean species share their space with the burrowers: mice, salamanders, squirrels, and shrews. Larger creatures are usually dependant upon the herbs, shrubs, and low trees, but birds of all varieties fly within the vertical stratifications. Some birds favor particular areas, like the woodpecker favors the plot between the shrubs and the canopy, but many use different areas for particular actions. Territory displays may be an upper canopy activity, while nesting is a lower canopy actively.

Tropical forests are the most diverse and life-explosive areas on a planet. Over 300 different tree species can be found in a single square mile in the most diverse of rain forests, but all rain forests have impressive plant and animal diversity. Tropical rain forests have five layers of vertical stratification, but these are poorly defined. The top-most layer, the emergent layer, is composed of the tops of trees standing 130-160ft. tall. Unlike every other forest, these massive trees are young, rarely more than a few hundred years old. In the constant light and moisture of the tropical rain forest, trees can grow 80 feet in height and 16 inches in girth in just five years. Like every other forest, old trees fall, creating open zones for new vegetation, but these holes are rapidly filled in comparison to other forests. The emergent layer pops up over the canopy layer, making the top of the rain forest look bumpy when viewed from a distance.

The next highest stratification is the canopy proper. Composed mostly of trees 80-120ft. tall, the canopy absorbs some 70-80% of the sun's energy. This traps moisture and keeps the forest underneath dark, humid, and still. Under the canopy proper is another continuous layer made up of trees with conical crowns. Under this layer is



the shrubby layer made of young trees, tall herbs, ferns, and shrubs. At last we reach the ground, occupied by low herbaceous plants and low ferns. These layers mix and shuffle, especially on hillsides (where light can more easily reach the ground), but are generally found in tropical rain forests throughout a planet.

Compared to other forests, tropical rain forests have a conspicuous number of plants dependent on trees to provide them a lift into the light. Epiphytes, climbers, and stranglers are found in great numbers in all tropical forests. The simplest of these is the climber. Climbers (lianas) are vines with stems ranging from fine to cable-like that reach the tops of trees and then expand into the size and shape of a tree crown. Climbers can gain the heights and loop back down to the ground only to ascend once more. Climbers grow prolifically in the rain forest openings, giving rise to the common perception of the impenetrable jungle.

Epiphytes and stranglers begin life the same way, but take different turns quickly. Epiphytes are plants that inhabit niches on trunks, limbs, branches, leaves, shrubs, and even climbers. Epiphytes have aerial roots, lodging themselves in the nooks and crannies of other plants. Mosses, algae, and lichens are common microscopic epiphytes, but the macroepiphytes are vascular plants. The roots of these plants never reach the ground. Many of these plants have developed desert-like adaptations because of their precarious moisture position. At the same time, they support aquatic life (some even have crabs!) in the pools of water they collect at the base of their stem. Stranglers, after attaching themselves securely, put down a series of long roots, eventually strangling the plant they occupy. An important strangler is the strangler fig that provides food for many different creatures.

The floor of most tropical rain forests is a thick mesh composed of roots from hundreds of different plants. Tropical rain forest soil is very poor, and the plants rely upon the top 12 inches of soil for the majority of their inorganic nutrients. These are supplied through the continual detrital rain falling from the forest itself. Enough detritus falls just on the nooks and crannies of the trees alone to support epiphytes (described above), and even more falls to the floor proper. In the soil, you'll find mycorrhizae, establishing a symbiotic relationship between the mycelium of a fungus and the roots of a seed plant. Since the soil is so poor, tropical rainforests are heavily dependent upon these little fungi, even more so than the boreal forest and many coniferous forests. The bases of tropical rain forest trees are often buttressed to support their vast height. As rain forest tree roots are very shallow, these buttresses (usually plank-like or stilt-like) help the trees get a good grip in the unsteady soil by spreading their weight over a larger area.

Surprisingly, although diversity of animal species is unmatched in the tropical rain forest, density is not. This is partly because of the complex vertical stratification in tropical rain forests; there is simply more space within which to support life. On grasslands, there's only the surface and just under the surface, but in a tropical rain forest, there are a hundred or more feet above ground in which life goes on. Extreme specialization of some species also deters high density, such as only eating the leaves of one particular tree or only laying your eggs on one particular caterpillar. But don't let this paragraph fool you; animal life in tropical rain forests is everywhere, and usually in some mind-boggling strange form.

Scrubland and Deserts

Scrubland and deserts cover more than 25% of Earth's surface. These two biomes are usually found in close proximity with each other. Scrubland is characterized by a large number of shrubs, few trees, and lots of grass. The size of the shrubs varies from the tall eucalypt shrubs that are 15-25ft. tall to the dwarf shrubs less than 16 inches tall. Most scrubland is the result of low rainfall, low soil-nutrient levels, and periodic fire. Scrubland can be created through logging, land clearing or land-intensive activities by intelligent species.



There are two main scrubland groups: warm scrublands (mediterranean or chaparral) and cold scrublands (heath). Warm scrublands have long dry seasons (usually 5-8 months) and warm-to-hot temperatures year-round. Those scrublands experiencing their rainy season in conjunction with winter often do most of their growing, fruiting, and flowering during winter, in contrast to most other biomes. Summer is usually a hot time with temperatures sometimes surpassing 100°F. During this dry, hot time, many plants die off completely, and some species survive only as seeds during this hard period. Other plants die back to underground storage organs like bulbs or tubers.

Water storage is important for scrubland plants, and they're well adapted for it. Some shrubs are deciduous, shedding their leaves for the dry season, just like others shed their leaves for the cold season. Some shrubs have small, leathery leaves to reduce water loss while others develop roots so deep they can access the water table and continue growing year round. There's a price to pay for this however. Because they're always green and growing, they attract the attention of grazers, both insect and larger grazers. The plants have therefore developed methods to counteract this. Some have armed themselves with thorns and tough leaves while others have developed chemical defenses involving strong, distasteful juices as protection from grazers, which also deter other plants from invading their territory.

Unfortunately, or fortunately depending how you want to look at it, these same juices are highly flammable. During the height of summer, these juices are heavily extruded to ward off grazers and eventually cause inevitable fires. Some bushes are so flammable that a spark from a falling rock can make them burst into flame. These fires destroy all the scrubs and allow herbs and grasses to have a strong period of growth for a few years. The shrubs return in under a decade, however, and their chemical defenses limit the space where grasses and herbs can grow between adjacent shrubs.

Cold scrubland (heath) vegetation is an assemblage of dense to semi-dense growth of shrubs adapted to fire. These shrubs have thick-walled cells and waxy, hard leaves with small surface area. Many of these shrubs are found in other ecosystems like deciduous forest. Heathlands only occur on nutrient-poor soils. They're extensive in



artic regions and common in alpine areas throughout the world. They're also found in lowland poor soils that are commonly waterlogged. Heathlands also experience fires just like their warm-climate cousin, but not as regularly.

Both types of scrublands often play an important successional role before being replaced by a forest if the soil is adequate. As many scrublands are the result of misuse by intelligent species, and given enough time alone, some eventually regenerate into forests. These scrublands are often thick with blackberrys, hawthorns, greenbriers, and dogwoods, which rank high as wildlife food.

Scrublands have their own particular wildlife. The ever-present insects, mule deer, coyotes, jackrabbits, sage grouse, kangaroo, wallaby, and many different types of rodents all make scrublands their home. Birds are common in scrublands, and many migratory birds use them in their travels. Several species are particularly adapted, and even dependent upon, farmland hedgerows. Since these hedges often stand for hundreds of years, the whitethroat, linnet, blackbird, and yellowhammer have all adapted to this specific niche. Sheep and goats are excellently suited to scrublands, being close-to-the-ground grazers.

Deserts are defined by rainfall: extreme deserts have less than 2.75 inches of rain a year, true deserts have less than 4.75 inches of rain a year, and semideserts have less than 16 inches of rain per year. Deserts occupy two distinct belts between 15° and 35° latitude north and south of the equator. Deserts generally form in three ways: through high-pressure zones, mountain ranges, and continental depth. High-pressure zones result from the sun's energy and the Coriolis effect, mountain ranges create rain shadows on their leeward side (most air moisture drops as rain on their windward side), and the interior of large continents are so far removed from the ocean that the winds have already dropped all their moisture by the time they get there. Where more than one of these comes into play at once major deserts occur, like the Sahara with its high-pressure zones and continental depth.

Deserts have a wide range of temperatures, both annually and daily. Deserts can be cold as well as hot. Since there is little moisture or vegetation to absorb solar energy, almost all (90%) of the sun's energy penetrates and heats the ground. This makes the temperature differences from day to night great. Desserts have stark topologies, ironically often partially shaped by water. Without vegetation, the unprotected soil erodes away under the strength of strong windstorms. When rare rain occurs, it is often very violent and forms flash floods through arroyos out onto the playas. Eventually the water finds a low spot, and for the briefest time, lakes stand in the desert. But they quickly evaporate away under the unforgiving sky, leaving only dry lakebeds, glistening with the salt particles left behind from the leached soil.

Dessert plants vary depending upon rainfall. Semideserts can verge on being grasslands or scrublands, while extreme deserts have very little plant life and only in certain locations. Common plants to all deserts are cacti of some variety and short grasses, usually bunched as opposed to turf. Some cacti grow to massive size like the saguaro, but most are much smaller. All of them are well adapted to the limited rainfall and possess strong defenses (often thorns or chemical defenses) against what few grazers live in the desert. Some plants (drought evaders) only live during the brief periods of rain, and then die after making seeds for the next time moisture is available, but most dessert plants are drought resisters.

Animals develop the same two adaptations. Some are drought evaders that go into a dormancy stage during dry periods. For example, the spadefoot toad remains underground in a gelatinous-lined, watery cell and only makes brief reproductive and feeding appearances during the "rainy season." Intelligent species in the desert are not above making these toads' watery cells a source of water in necessity. Nothing's quite as refreshing as a bit of toady



water to quench a thirst! Desert food webs are generally simple in comparison to other biomes, both in width and length. In semi-deserts, like on savannas, termites can play major roles in the ecosystem by reducing, transporting, and concentrating nutrient resources.

Reptiles are common in deserts along with birds. Reptiles need significantly less food than mammals, and birds have a big advantage with flight. Since resources are often scattered over large distances, flight makes survival easier than terrestrial movement. Few large animals call the desert home, but camels, oryx, wild horses, pumas, and coyotes successfully survive the desert's challenges. A few rare herds of elephants survive in the true desert by constantly moving from oasis to oasis and mixing their environment with forays into the savanna. These elephants of the desert remember the location of each oasis, even though some are days apart through sandy country.

Rivers and Lakes

The first of our aquatic biomes, rivers and lakes are created by water's search for equilibrium in its environment. Only a fraction of a percent of all the water on a planet is in rivers or lakes, but this fraction is very important to life. Rivers and lakes are always life-rich zones, especially in harsh dry lands. Besides their life-giving similarities, rivers also share physical characteristics. Every river, regardless of its size, begins somewhere as a spring or a seepage area, or they begin as an outflow from a pond, lake, or glacier. The water drains away from its source, following the lay of the land and underlying rock formations. This rill erodes small furrows that eventually turn into gullies. As it continues its downward movement, especially in steep areas, the water picks up a load of debris and carries it along. This helps the river cut more quickly as debris-laden water abrades the ground and rock faster than water without debris. Sooner or later the water deposits its load on its bed, along its bank, or in a pond, lake, sea, or ocean. In a mountain, this erosion eats away more strongly at the head of a gully, eventually cutting it backward up the slope and increasing the drainage areas.

Close to its source, a stream is usually small, straight, and swift because of the generally steeper gradient, and some possess waterfalls or rapids. Downstream, where the gradient is less steep, the stream's speed decreases, and it may start to meander, leaving behind its load of sediment on its banks or on its floodplain. Whenever a stream flows into a lake or a river flows into the sea, the speed of the river is suddenly checked by the large body of water. This forces the river to quickly deposit most of its debris load in a fan shaped pattern known as a delta. These deltas can be immense, but most of them are much smaller.

Streams are classified into orders depending upon their merging. For example, streams without any tributaries are first-order streams. Whenever two streams of the same order merge, they become one stream of the next highest order. In other words, a second-order stream is created when two first-order streams meet, and two second-order streams joining together create a third-order stream. Streams are generally headwater streams if they belong to orders 1-3 (around 16 inches to 30ft. wide), medium-sized streams if they belong to orders 4-6 (around 30-150ft. wide), and rivers if they belong to orders 7-12 (around 150ft. to a mile or more wide). These are useful approximations, and as always, some rivers are atypical.

River speed and size determine river life. Fast rivers are more barren than slow ones, and large ones are more populated than small ones while higher order rivers have larger organisms and usually more diversity as well. Few plants can live in streams with a stony bed, but mosses, liverworts, ferns, shrubs, and trees often grace their riverbanks. In dryer climates, trees and shrubs can follow streams or rivers through terrain they could not normally survive. Headwater streams are typically swift, fairly cold, and often lie in forested regions. 90% of their organic input comes from detritus





from the surrounding terrain falling into the stream, with a large portion of that being leaves. Headwaters that are out in the sunshine can get the majority of their organic material from autotrophs, but even then, most of that material ends up in the detrital (as opposed to the grazing) food chain. At this point, all creatures are fairly small as the streams are fairly small, but these headwater streams and medium-sized streams act as detrital collectors from their drainage basins. Feeding a full-sized river with great amounts of detrital material provide a good stable base upon which to support larger life. Full-sized rivers support many creatures. Insects, fish, birds, mollusks, crustaceans, hippos, crocodiles, turtles, manatees, otters, beavers, and even freshwater dolphin all live within the water. The river also supports life outside of its banks simply by being a source of drinking water.

Lakes are depressions in the landscape filled with water. This doesn't sound like much, but lakes have long entranced intelligent species with their ready resources. Lakes are anywhere from 3ft. to 6,500ft. deep (or deeper) and provide a constant resource to intelligent life. Along their banks, lakes possess very similar vegetation and wildlife as do rivers, but often without as great a worry of flood. Lakes are vertically stratified just like any three dimensional environment with certain species favoring shorelines while others prefer the depths. Lakes provide a constant source of water, and life is denser near them.

Both the vegetation and wildlife around lakes depend upon the surrounding landscape. However, lakes can have a geographically isolated effect upon the water-breathing creatures within them. In this manner, lakes function like aquatic islands; places where evolutionary specialization occurs. Old and large lakes can have many species unique to their waters and can even hold the last few remnants of ancient species that have been out-competed by newer species throughout the rest of the world. Every great lake has its special monsters.

Swamps and Marshes

Swamps and marshes are wetlands where the rivers and lakes mesh with the soil, lands in which the water is just as important as the soil in life's movement. Wetlands come in three basic varieties with significant differences: basin wetlands (wetlands created by depressions in the land and by water flowing vertically), riverine wetlands (wetlands created by rivers and streams and by water flowing in one direction), and fringe wetlands (wetlands created along the coast of large lakes, seas, or oceans and by water flowing in two directions). Wetlands dominated by herbaceous vegetation are called marshes while wetlands dominated by trees are called swamps. Wetlands in which a significant amount of water is retained in decaying vegetation are

called peatlands or mires. Peatlands dominated by sedges and in which water flows up are called fens. Peatlands in which the majority of the water arrives in the form of precipitation and are dominated by sphagnum moss are called bogs. Moors develop where the compressed peat of mires acts as a barrier between the water and the soil. The water collects on top of the moor (much like water and permafrost actually) and forms a perched water table above the true soil. Some of the most dangerous bogs are termed quaking bogs. These bogs form when a lake basin slowly fills in from above as layer after layer of sphagnum moss falls to the lake floor. Eventually large floating mats of moss completely cover large pools of water, creating a death trap for any unlucky or foolish creature.

Swamps and marshes are very rich ecosystems with productivity of the best wetlands matching that of rainforests. Vegetation is measured along the hydrosere, an imaginary line running from the dry outer edges to the heart of the wetlands. Along this line plants slowly adapt to the increasing water levels. Sometimes as plant material builds up, water plants (like waterlily) are slowly replaced with emergent species that normally root in the shallows. These emergent species often grow fast and thick, papyrus being a good example. Papyrus forms in floating mats that break away from the main body and float away (similar to icebergs calving off of ice shelves, but much smaller of course).

In swamps trees compose the main part of the vegetative biomass, and they are adapted to their submerged existence. As the ground is unstable, they develop buttressed roots to keep them upright. They often develop aerial roots that peep over the water top to collect needed oxygen because there is very little oxygen in the soil under the water. This is particularly evident in mangrove swamps. Mangrove trees, whose stilt-like roots provide both stability and oxygen to the plant, dominate mangrove swamps. Mangrove swamps are salt-water swamps found along coastlines that play a slow and important role in claiming land from the ocean. As they grow and die and grow and die, they slowly build up the swampland above the sea level while pushing the boundaries of the swamp further out into the sea. The basket-like complexity of the mangrove roots provides a haven for the young of many ocean fish.



Marshes are composed mainly of herbaceous vegetation like bulrushes, papyrus, cattails, wild rice and many different types of grasses. Marshes can be both fresh water and salt water. The majority of marshes tend to be fresh water, but along seas or oceans, salt-water marshes are fairly common. Salt-water marshes often have tidal concerns not addressed in freshwater marshes. Depending on the tide, the marsh can be nearly dry, almost completely submerged, or any step in between. These marshes are the home to the ubiquitous fiddler crab. These fellows have both lungs and gills, endure periods of cold winter without oxygen, have salt-control systems allowing them to move freely between salty and fresh water, omnivorously eat algae and small animals, and turn over the soil like earthworms as they dig their burrows.

All wetlands are rich with animal life. Their many different water levels provide great environments for crabs and many other crustaceans. Fish find wetlands good environments because they provide continual detrital food as well as good shelter for the small fry. This often leads to vast amounts of waterfowl that find food comparatively easily. Herbivores find wetlands a haven of many sorts. Snails, geese, mallards, and hippos all find plenty of food. On prairie marshes, the muskrat is often



the top herbivore, capable of eating out emergent vegetation to create open-water marshes. Mink prey upon the muskrats and usually keep their numbers to reasonable levels. Other small predators include raccoons, foxes, weasels, and skunks that keep the waterfowl numbers in check. Larger predators feature the fearsome crocodile, alligator, and anaconda. These three reptiles are renowned ambush predators.



Coastlines, Oceans and Islands

Oceans, coastlines and islands are as variable as the climate in which you find them, but they almost always share some similar characteristics. Freshwater coastlines teem with life as animals of all sorts enjoy the constant water source. Saltwater coastlines teem with marine life, as over 90% of all the life in an ocean exists within 150 miles of shore. Freshwater islands usually find themselves occupied because of their defensive abilities, and saltwater islands are breeding grounds for strange and unique creatures, becoming an oasis of marine life in the deep ocean.

Far in the north and south of a world, coastlines are the rare places where life exists. Cold breeding grounds for seals, walruses, penguins and many different fish create a ring of life around dead, barren land. The coastlines of the rest of the world are just as important, even if not occupied by thousands of languishing mammals. Coasts vary with environments; they can be sheer cliffs, sandy beaches, mudflats, rocky beaches or any combination. Coasts are constantly changing as well, not only from undercutting and sand migration, but also from tidal effects. On some coasts, the tidal range can





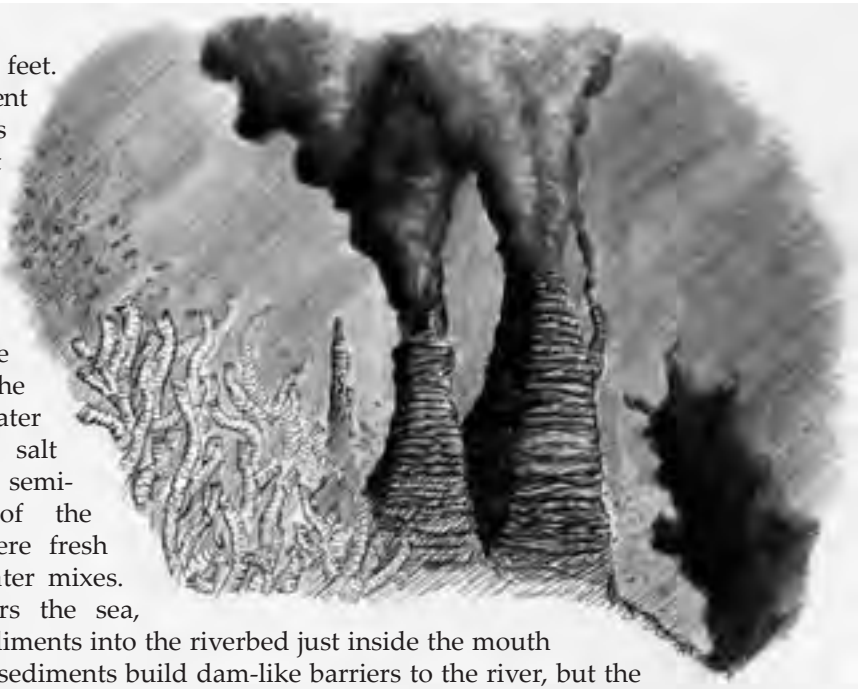
be greater than 50 feet. All of these different environments contain different species adapted to the rhythm of the coastline.

Estuaries are a type of coastline where rivers feed into the ocean. Freshwater mingles with the salt water to create semi-enclosed parts of the coastal ocean where fresh water and salt water mixes.

As the river nears the sea, they drop their sediments into the riverbed just inside the mouth of the river. These sediments build dam-like barriers to the river, but the river keeps finding new ways to the ocean. Though this process sounds similar to delta building, the process that makes estuaries is not as advanced as deltas. You could say that deltas were at one time estuaries, but not all estuaries turn into deltas. If a river's flow is slow, the ocean tide may roll up the river, creating a tidal surge and giving rivers miles from the sea a brackish taste. It is not unheard of for sharks to swim up these tidal rivers and are sometimes found miles inland. But most rivers don't experience this effect and instead throw out a layer of freshwater over the salt water of the ocean. Since freshwater floats on salt water, this area of fresh water created by a river can sometimes be immense. For example, the biggest river on our base planet, the Amazon River, creates a layer of drinkable freshwater over the ocean 40 miles out to sea before mixing with the salt water. Needless to say, the marine life in this area is unique.

Coastlines are so often rich in life because they provide photosynthetic phytoplankton (especially where oceans upwell nutrients). Phytoplankton are like the plants of the sea; they are the building blocks upon which almost all ocean life depends. Remember my earlier statement that terrestrial food web rarely exceed four trophic levels? In the open ocean, there are commonly five to six different trophic levels. Phytoplankton are eaten by herbivorous zooplankton, who are eaten by carnivorous zooplankton, who are eaten by small carnivorous fish, who are eaten by larger carnivorous fish, who are eaten by very large carnivorous fish (dolphins, sharks), who are then sometimes eaten by the monstrous tyrants of the seas. Ocean food webs are often long and wide, but some species intensely specialize into smaller food webs just like their terrestrial neighbors.

The deep ocean is a different matter completely. Life is strange, harsh, and largely depends upon the dead matter that falls from above in a constant putrid rain. The deep ocean is dark, cold, and highly pressurized, but creatures calling the endless depths their home are well equipped. Bioluminescence is common and used for attracting prey (angler fish), defensive purposes (some jellyfish), and as a way of finding a mate. At the bottom of the sea are filter feeders (slow detritus-eating bottom movers), quick opportunist detrital feeders, and predators. Food is relatively consistent though scarce, and feeding frenzies ensue when great amounts of detrital material makes its way to the bottom. When a large creature (like a whale) dies and sinks to the sea floor, it provides plentiful food for the benthic creatures for a year and half.



The deep ocean is also home to hydrothermal vents found along volcanic ridges. These springs constantly vent very hot water rich in minerals (mostly sulfides). Temperatures around these vents get as high as 550°F, heating the surrounding water from its typical 35°F to 45°F-60°F. These vents support a rich diversity of unusual life. Giant clams, mussels, polychaete worms, and crabs of many different species live around the chimney-like black and white smokers (vents are defined by the color of material they extrude). The primary producers in this environment are chemosynthetic bacteria that oxidize the sulfur compounds to form organic matter. The consumers of these creatures have developed unique ways to avoid sulfur poisoning that would happen with most other organisms.

Caves and Underground Environments

There are three main types of caves: limestone caves, lava caves, and ice caves. Limestone caves are the caves most familiar to explorers, and they are the most common. They form when water dissolves limestone on its way through the water table or down to the table. The water dissolves limestone due the acidity picked up as it falls through the air and travels through stone. Most other stones are more resistant than limestone (although gypsum and halite are exceptions to this rule) and are not eroded in such a manner. Over long periods of time, these small erosions create large caves or even massive cave complexes.

This erosive process usually begins on the surface. Over time sinkholes form on the surface feeding the cave system. Over these cave systems, water doesn't flow very far on the surface before descending into a sinkhole. Some sinkholes become clogged with debris, plugging the drain into the cave system and creating sinkhole ponds. These sinkhole ponds also unplug and drain several acres of water into the cave system overnight. More disturbing are sinkholes that result from collapsing caves. These sinkholes are as deep as 150 feet and several acres in size. The pockmarked terrain feeding cave systems is called karst topography.

Within the cave proper, the same erosive process creates many mineral decorations. As the mineral-laden water moves, it deposits some of its load through evaporation. This creates the numerous pleasing formations found in caves. Many of them are carbonate speleothems, and they're classified according to their shape. Stalactites, stalagmites, soda straws, cave bacon, columns, draperies, and flowstones are all carbonate speleothems, decorating natural underground environments.





Opposite of limestone caves are lava caves, created through the movement of lava from geological hotspots (mostly volcanoes). Lava flows eventually enclose themselves because the outer layers harden while the inner layers still flow, carving long tubes under the hardened shell. If the lava evacuates the tube, lava caves are born. Lava caves share formations with limestone caves, but they're formed differently. Cooling lava creates tube formations as it splashes, drips, flows, and spatters.

Ice caves are caves created in large pieces of ice, usually glaciers. Most ice caves form as flowing water etches open areas within the ice. Sometimes ice caves form when ice breaks open, snow fills the crack, and the snow compacts into ice, though this method is more rare. Ice caves are particularly dangerous to explore, as they are the most transitory of all caves and often unstable. Unlike limestone caves and lava tubes, ice caves fluctuate faster than typical geography since water cuts through ice rather than stone.

In general, caves have a very stable environment in comparison to the surface. Everything changes much slower, though change does occur. Temperatures vary based upon air movement, and the slight discrepancies between the deep cave and the surface cave create wind. The slight differences in humidity also create the cave's form of rain: the alteration of the dew point. Some places are naturally more humid and wet than others. But all of these things only occur in "live" caves. "Dead" caves no longer have water flowing through them and contain almost no life.

Cave life is minimal without photosynthesis. There are three types of cave life. Trogllobites can only complete their life cycles inside a cave system (eyeless fish, shrimp, and crayfish). Troglophiles can complete their life cycles in caves if there is food enough (worms, snails, cave crickets, cave spiders). Troglaxenes cannot complete their life cycles inside a cave, but use caves for shelter or other important behaviors (bats, rats, flies). Much of the life depends upon the detrital chain; for example, flowing water brings decomposing creatures to feed the eyeless fish, shrimp and crayfish. Some caves support chemosynthetic life, though this relies on hydrothermal venting or water traveling through super-saturated stone. Magic plays its greatest role underground, where magiotrophs form the base for a complex underground food chain.

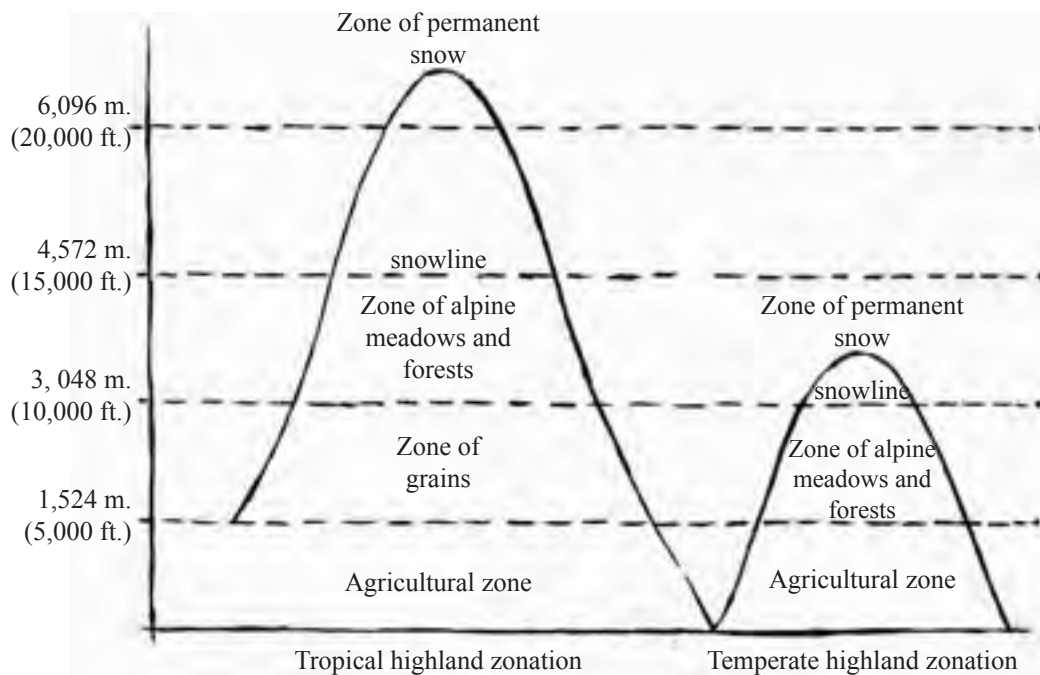


Mountains

Mountains are the most variable of terrain. Within them you may find boreal forests, grasslands, wetlands, and scrublands. Almost any of the other environments may be found in mountainous regions. Mountains are most influenced by latitude. If two mountains are of the same height, the mountain in the higher latitudes has fewer climate zones than the mountain found closer to the equator. The next factor is mountain elevation; for every 200 ft. (roughly) the average temperature drops 0.7°F. Another main influencer on ecosystems is rain; a mountain usually has a “wet” side and a “dry” side depending on the general direction of the wind. The difference may be slight, but rainfall differentials increase with tall mountains and wind that consistently flow from one direction. The last factor is sunlight. Many mountains have a sunny and a shady side that greatly influences what plants flourish. Mountains are a microcosm of the greater systems on a planet.

Mountains act as islands on an earthly sea. Their creatures develop in sheltered environments that tend to favor specialization and speciation. This is not to say that mountains only have unique species; many mountain species live both on the slopes and the flatlands. However, mountains facilitate small and specialized ecosystems when compared with the surrounding terrain. Some mountain ranges are home to dozens of different species of the same creature, and some creatures are only found on particular mountains. This effect is most noticeable on tropical mountains, as the cool temperatures found on their slopes are to be found nowhere else for hundreds, perhaps thousands, of miles.

Reading over these short descriptions of mine, I see their incompleteness. Each one of these concepts and environments are complex enough for an entire library's worth of books, and my attempt to cull such massive amounts of information into a few spare paragraphs seems feeble. For all our power of discernment, perception, and synthesis, we are still severely limited in one unfortunate manner. Without asking the right questions, we cannot hope to find the answers so easily perceived once the proper questions are asked. Hopefully these writings spur the right questions in your world-building effort. If nothing else, they should prevent you from making some basic faulty assumptions.



Interlude



Kierian gazed into the mirror, hardly recognizing the eyes that stared back. His ink-stained fingers touched his cheek; the contact did little in way of reassurance. He found it difficult to enumerate the subtle changes in his countenance. Though he wasn't aged, his eyes garnered a visage only old age and wisdom granted. Like his hands, once rough and calloused from battle, his face lost its coarse quality, graced with lines from an oft-furrowed, pensive brow. Kierian was uncertain how such a softened face emanated strength and authority rather than lessening; yet he did not doubt his growing presence.

The godling marked time by the moments between working, and Kierian could no longer ignore the sum of such moments. How much time has passed since he began creating? What of his world? Were they all still there, frozen since the moment of his ascension? Or are they all long past bones in their graves? These thoughts tread lightly, but Kierian felt their weight increase steadily. He assumed becoming a god provided him with more answers. He didn't anticipate that he would ask different questions once he got there.

Noj entered whistling and sidestepping a cheerful jig, attracting Kierian's gaze from his reflection. The gnome was more burdened than usual: more rolls of parchment under his arm, more knickknacks and notes bulging from his pockets, and a definite gleam in his amber eyes. "Do you know what today is?"

"Gnome Appreciation Day?" Kierian posed with amusement at his assistant's gait.

"No. Today you create your world and fill it with creatures. No more rulers and compasses for you." The giddy gnome danced, putting everything away. "I was up all night with your notes and sketches, and I've run a few dozen schematics. So far the only problem seems to be with the Petola fault line, but it's nothing a few mountains can't solve."

Kierian nodded complacently with a curt, "that's good."

Noj's eye's narrowed with study. "Something the matter?"

"No," Kierian put his hand on the curling parchment and feigned interest in the Petola fault line. "What makes you think something's wrong?"

"It's just that I couldn't help notice your lack of enthusiasm. You've been wanting to test your divine abilities, yet not so much a 'hurrah' upon my announcement."

The godling retracted his hand and his feigned interest. The parchment rolled inward. "How long have we been at this, Noj?"

"Well, time works differently here, so it really depends on which standard of time you compare it to. If you are using standard divine time..."

Kierian shook his head, forgetting the gnome's literal tendency. "No, that's not what I mean. If I were to go back, how much time has passed since I killed Korgol?" Kierian ran his hands through his once-short hair.

Noj removed his lenses with his small, wizened hands. "You can't go back. You know that."

Kierian grinned a pensive, devilish, private smile and laughed tersely. "Yes, I suppose I do. I'm a god after all."

"Come. We'll put your world together." He unraveled the parchment and weighted the ends. "Then we'll start with the dragons."

Mapping Your World (Part II)

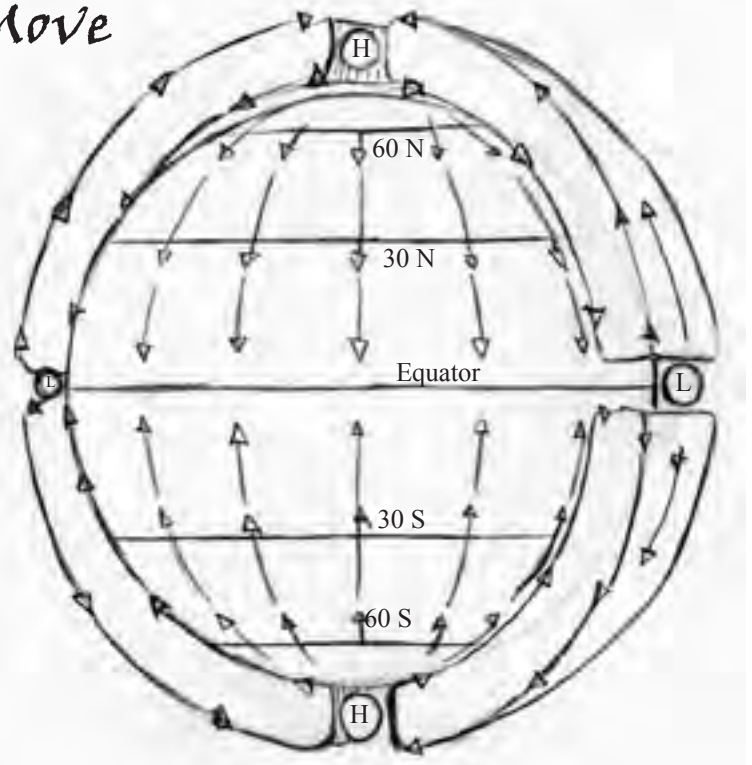
Step Five: Weather Generative Forces

Mapping weather patterns is the most complex subject so far and requires more information than the previous steps. Only after we place all the landmasses can we infer global weather patterns. Assuming a world relatively similar to Earth in tilt and orbit around the sun, global weather patterns follow a few basic rules. Weather is a planet's attempt to equalize the heat it receives from the sun. The sun's rays warm oceans and lakes, and heat rises off land and water into the atmosphere. The warming of the atmosphere results in weather. Hotter air becomes less dense, rises, and displaces the cooler air in the atmosphere. The poles are cooler because the sun's rays transfer less heat due to their low angle near the poles. Near the equator, the sun's rays strike the planet more directly and transfer more heat. This difference in heat distribution drives air currents and ocean currents in a pattern of motion called convection.

Besides this heat imbalance, there is one other major creator in weather patterns: the Coriolis effect. The Coriolis effect is the curving of the air and water currents due to a planet's rotation. Since most planets rotate, you can thank the universe's preference for circular movement for making your work more complex. As the cooler air from the poles makes its way towards the equator, the planet rotates eastward. The air current thus bends towards the west with respect to the surface and continues to bend because the speed of the surface increases the closer the air gets to the equator. The reverse happens with the warm air that rises from the equator and makes its way to the poles.

It Does Not Move

Weather is less complex on planets that do not rotate on an axis. Planets rectify the heat imbalance with a simple airflow and a water flow. Generally, a cool wind blows from the poles to the equator in a straight line. At the tropics, the air warms and moves to the top of the atmosphere, heading back to the pole from which it came. Water currents follow the same general pattern. Deep cold waters flow to the tropics, and warm tropical waters flow back to the poles. The only changes in airflow result from mountains or large bodies of water, while continents stand as the sole disruptors to water flow.

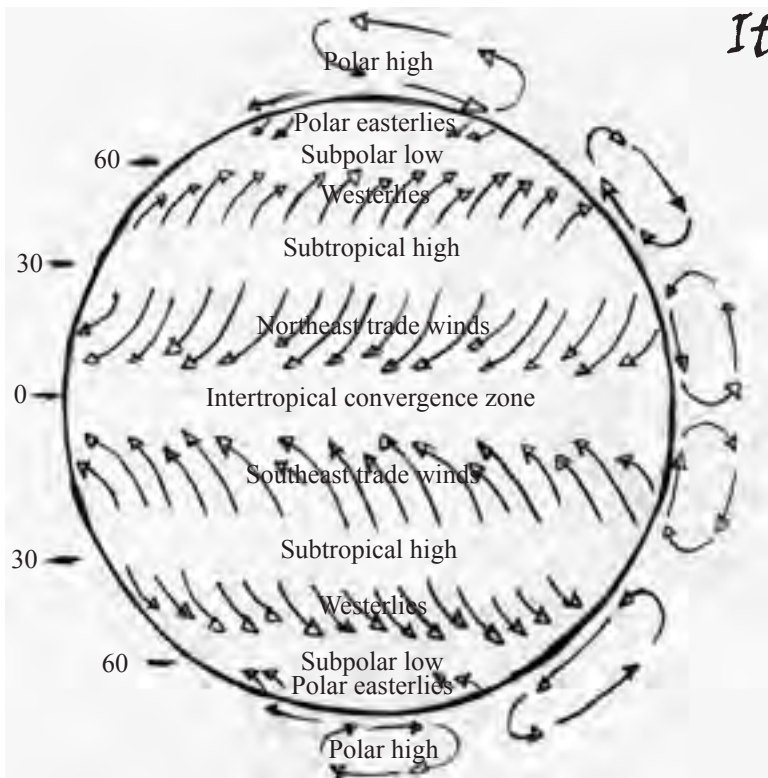


The Coriolis effect forces “pile-ups” of this upper level air because it can’t make it’s way unimpeded back to the pole. The air north and south of the equator (at around 20°-30° north and south) can’t escape to the poles fast enough. High-pressure areas build up, push down on the planet, and create winds towards the north and south. These winds are also deflected because of the Coriolis effect and move diagonally westward. This equatorial gyre is repeated twice more until they reach the poles. Each gyre creates an alternating wind pattern. The trade winds move west, the westerlies move east (given that name because the wind blows from the west as it moves east), and the easterlies move west.

Air and water gyres are the final things created by the Coriolis. Water and air are both affected by the planet’s rotation and develop not only convection currents (the currents established by temperature differences), but also giant rotation currents. North of the equator, water and air circle in a clockwise pattern: south of the equator, water and air circle in a counter-clockwise pattern. The air currents heavily influence the surface-water currents, but deeper ocean currents (similar to the upper air currents) do play a small role in water patterns. Bodies of water, landmasses, and mountains further complicate these general air and water patterns.

Water and Land

Although the sun is weather’s primary driver, the oceans provide the life-giving water that the sun’s heat moves through the planet. The movement of water on a planet is fairly complex, but it can be easily simplified for mapping purposes. Water evaporates under the sun’s heat and collects in the air forming clouds. When the moisture level of the air becomes greater than it can hold (usually because a temperature change) rain falls back on the surface of the planet. The movement of air carries this water vapor off the oceans and onto the land (most of the rain on a planet comes from oceanic evaporation) and into the life on the land.



It Does Move

This diagram shows the Coriolis effect at work on Earth and can be applied on any other planet of similar make. Notice how surface air is flowing up at the equator and at the subtropical lows. High-altitude air is flowing to the surface at the subtropical highs and the polar highs. This also shows the gyres going clockwise in the north and counterclockwise in the south. The polar highs produce a very strong and steady wind, called the katabatic.





Water is generally subject to the air currents and their subsequent rain patterns, but it also influences them. The oceans heat and cool slower and to a lesser degree than land. This difference is very important. Water can store about five times the heat energy that land can store, which means water can absorb about five times more energy without its temperature increasing. The sun's rays are also diffused over a much greater area of water (since light can penetrate water), which further reduces the maximum temperature water reaches in comparison with land. Water is also mobile allowing convection to distribute uneven heating easier than land and the unlimited amount of moisture in water means it can evaporate (and hence cool) unlimitedly when compared to land. All of this means that because water retains more heat, it cools slower during winter than land; conversely it takes longer to heat up once summer arrives again.

All of water's unique properties have significant effects upon weather, and over time, climate because it changes temperatures. The hottest and coldest places on a planet will be on the interior of continents, far away from the influence of the oceans. The oceans act as a great heat sink; absorbing heat in summer and releasing it in winter. You should look at the amount of water in the northern and southern hemispheres of your new planet. The hemisphere with the most water will have less variance in annual temperature ranges for each latitude. On Earth, the Northern Hemisphere is 39% land while the Southern Hemisphere is 19% land. This causes the more extreme temperatures typical of the Northern Hemisphere.

Land has just as great an impact upon weather and climate as water. Unlike water, land quickly gains and loses heat. This leads to generally more erratic winds over landmasses than over oceans as the land cools quickly and in different proportions depending on its vegetative cover (the more plants, the slower it gains and loses heat; the fewer plants the quicker the process). This difference in cooling is noticeable in mountainous areas as mountains have more surface area per square mile than most other terrain types and particularly noticeable in deserts, which lose their day's heat very quickly. Another important difference in weather over the land and over water is humidity. More evaporation occurs over water, so most humid air (the air that brings rain) comes from evaporation over oceans or other large bodies of water, like the Great Lakes. Most of the rain falling on the continents comes from evaporation off the oceans. Thus, if a continent is large, the centers will be very dry because most of the moisture has already dropped out of the wind. Central Asia (Gobi Desert) is a good example of this.

Terrain types and their respective vegetation levels influence weather through their respective heat absorption and release levels, but mountains are the only geographical features capable of affecting weather patterns outside of the sun's influence. Mountains are physical barriers to wind and the cause massive disturbances in weather patterns, particularly rainfall. Air rises as it goes up a mountain, cooling it. This cooling reduces the amount of moisture the air can hold and often results in rain. This means, that in general, a mountain range will have a wet and a dry side. If the range is a large one and winds are fairly consistent in their direction, the mountain can create a rain shadow, effectively creating a desert. This can even happen on a smaller scale, like the island of Hawaii, where the eastern side receives the trade winds and an annual rainfall of 150 inches while the other side of the island only receives 9 inches of rain a year. A few (or a pair in the case of Hawaii) mountains can dramatically change weather.

Mapping the Phenomenon

Mapping all of the complexities of weather is something simply beyond the need of most new worlds. The general principles discussed above should provide you with enough raw information to look at your maps and make some decisions.

First, you should basically mimic the air patterns as influenced by the Coriolis effect. This provides a baseline that is agreeable to every other assumption about the working of weather. Adopting the basic ocean currents to the new world is the next step. Continental placement will affect this more than air patterns, but as long as the same general patterns of movement (gyres, areas of lows and highs) are maintained, the currents should closely mimic the Earth's because they're also influenced by heat and rotation. Our goal is to make a map that takes into account the natural functions of the universe. Before we can put down an ancient jungle kingdom, we'd best make sure it's where the planet is going to naturally create a jungle. We can use magic to do it, but pre-planning avoids a lot of post-creation headaches.

Around the equator and around 60° N and S there are wet zones. Around 30° N and S (and more exactly the tropics) will be dry areas. This is a gross simplification, but it'll get us where we need to go for right now. Mountains will affect the degree of rain, so be certain to indicate rain shadows based upon wind movement.

Step Five: Example

To map the weather, I used the equator, the tropics, arctic circles, and latitudes 30° and 60°. Since my tilt is very Earth-like, I don't have to worry about weather patterns drastically diverging from Earth norms. I drew in the wind patterns based upon the Coriolis effect. After the air, I mapped the water currents, showing the typical gyre patterns. This is fairly straightforward, even though it's a very complex physical process. I then mapped in the wet and dry latitudinal zones, again based upon the Coriolis effect.

Throughout this process, I've made a lot of arbitrary, but plausible, decisions. The movement of the wind is more complex than I've shown, but again, the pattern generally follows what I've put down. The same is true of ocean currents. They almost all follow the gyres according to their hemisphere (clockwise in the north, counterclockwise in the south), but there are some exceptions. I have a few currents that split and head in differing directions, but even these currents eventually follow the overall pattern. For example, the current off the east coast of continent B splits and flows up the coastline while the other part gyres up to continent C. The coastal flow up continent B eventually gyres back and rejoins at continent C. A good example of split currents is the Atlantic Equatorial Current. It travels from Africa to South American and splits. One flow goes south along the east coast of South America, and the other flows along the northern coast of South America. The southern split maintains the traditional counterclockwise gyre, but the northern current crosses the equator and eventually gyres clockwise as part of the Florida Current and the Gulf Stream. Generally, cold currents are moving from high latitudes to low latitudes, while warm currents are moving from low latitudes to high latitudes. On my world, a strong cold current flows from the south to the north along the west coast of continent E while a warm current moves north along the east coast of continent B.

Step Six: Climate Zones and Rivers

Climate is where rain and temperature mix, therefore latitude, altitude, and wind pattern all shape climates. An idealized world has the pattern shown in the List of Climate zones. Place each type of climate on your map in roughly the same manner. Again, pay attention to where the wind blows and where the mountains are. General elevation may play a role depending on how vast an area you've elevated. The Tibetan plateau is a good example of an elevated area changing the expected climate. More than elevated areas, ocean currents play an important role in determining climate. Warm currents heat the air around them, making Europe very habitable for example, while cold currents can temper a warm climate. Cold currents sometimes reduce rainfall along





coastlines because they cool the air above them, restricting the amount of water the air can carry.

Rivers are easy to place at this scope; we're just looking to place a few major rivers on each continent. Remember that water flows downhill and wet areas have more water than dry areas. Rivers are the easiest part of this step, so have fun and pay attention to where they're going, because they'll be the cradles of your forthcoming civilizations. Overall, this step is the most complex of all the mapping steps. The vast diversity of climate and the intricacies that make up each climate can't be modeled without extraordinary effort. But even this very basic climate map of the world will help when discussing cultural development.

List of Climate Zones

Arctic/Polar Region-North of Arctic Circle
Wet Zone- Mostly south of 60 N
Transition from Dry to Wet Zone
Transition to Desert Zone
Desert Zone-Tropic Circle and 30N
Transition to Desert Zone
Transition from Wet to Dry Zone
Very Wet Zone- Equator
Transition from Wet to Dry Zone
Transition to Desert Zone
Desert Zone-Tropic Circle and 30S
Transition to Desert Zone
Transition from Dry to Wet Zone
Wet Zone-Mostly north of 60 S
Arctic/Polar Region-South of Arctic Circle

Step Six: Example

Following the general wind patterns, I first placed equatorial areas with heavy rain. The mountain range BE is packed with water because it's not only on the equator, but the mountains catch the water and send it downstream in torrents. The northern part of continent D is very wet since there's nothing interfering with winds, as is the northern part of continent A. These areas are probably rainforests because they have a lot of rain and plenty of sun.

The next step is to place the transitional areas that are more wet than dry. These were placed north and south of the very wet areas. Most are probably deciduous forests mixed with the remnants of rainforests, grasslands mixed with deciduous forests, and the beginning of the dryer lands. They could be simply grassland as well. Notice that these two zones are mostly within the tropic bands. Their placement also reflects what the wind is doing. On continent A, this zone loops around because the wind is coming from a particular direction while on continent D, the zone remains more horizontal for generally the same reason. You could change these zones based upon what you wish to happen. As long as they're relatively in the same location, such change can easily be supported.

The next step moves into dryer lands by placing the transitional dry zone. These are mostly grasslands/scrublands, and they generally abut the transitional wet zones. Such zones are plentiful throughout the dry latitudinal zone and often abut a desert zone. I didn't place these zones next on the map, however. It's easier if you go right to the deserts, and then look to see where these zones fit best.

Deserts are almost always along 30° N, 30° S, or the tropic lines. I placed my deserts along these areas and paid particular attention to wind direction. The desert on continent A is in a dry zone, but it also has a range of mountains that interfere with rain,

so it stretches farther north into the wetter latitudinal zones. A similar thing happens with the desert on continent D. The desert on A exists because it's in the dry zone, but notice that I placed a dry transition zone along the southern coast. The ocean air is relatively dry in this zone, but what little moisture it holds drops along this curve. All things considered, the desert on A is probably fairly wet for a desert until you go in deeper. The great desert on E was the hardest to place because there are many factors to weigh. It is a mixture of dry zone, wind patterns, mountain range and large landmass. For these reasons, I decided that this was the Sahara of my world: the big, sandy, unfriendly desert.

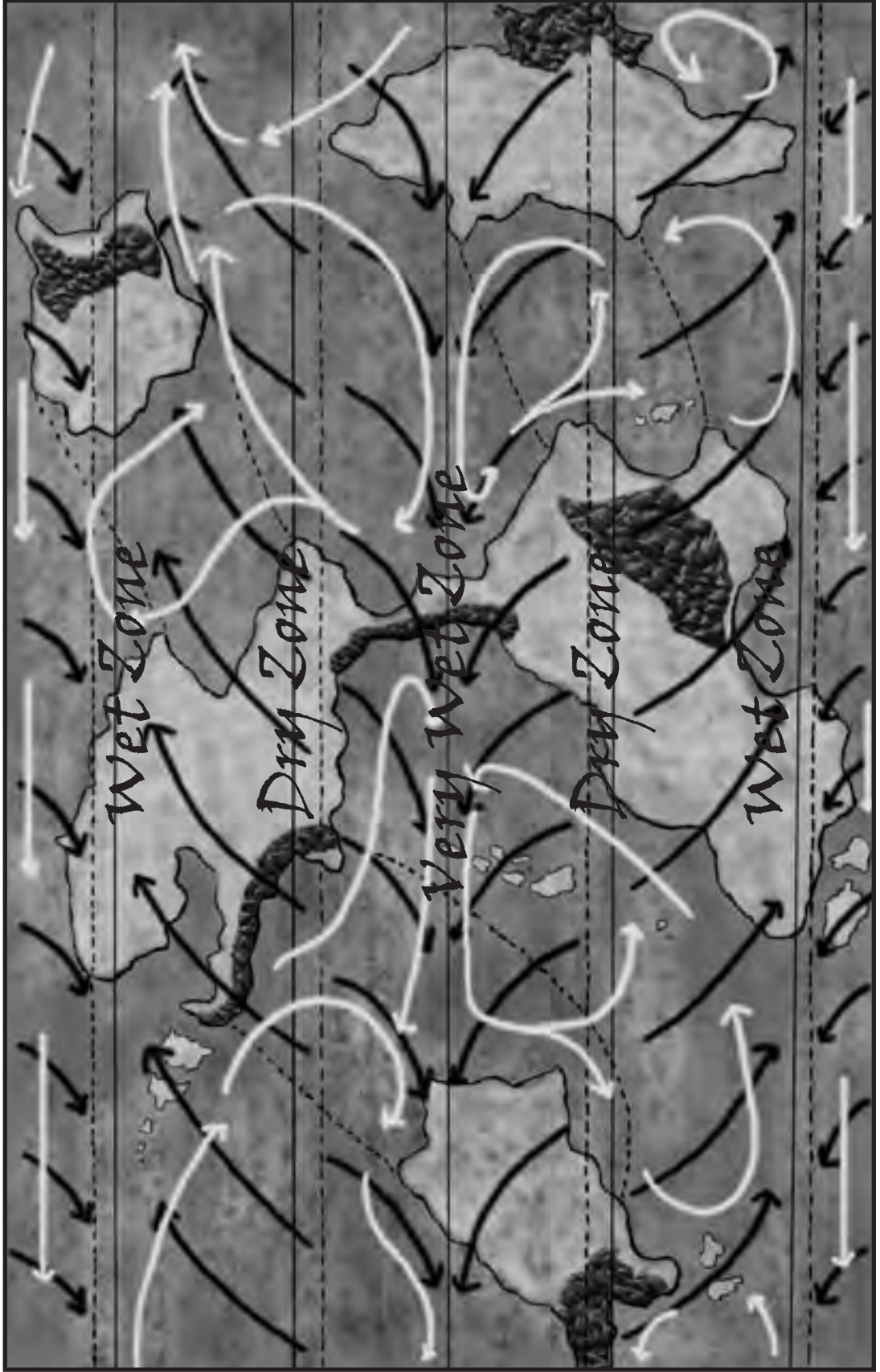
I then placed the dry transitional zones between the deserts and the wet transitional zone. It's much easier to do it this way, even though you have to consider the next wet transitional zone leading to the wet band around 60° north and south latitude. Again, I found it easier to just jump zones and place the midlatitude wet zones before placing both the dry transitional zones and the wet transitional zones.

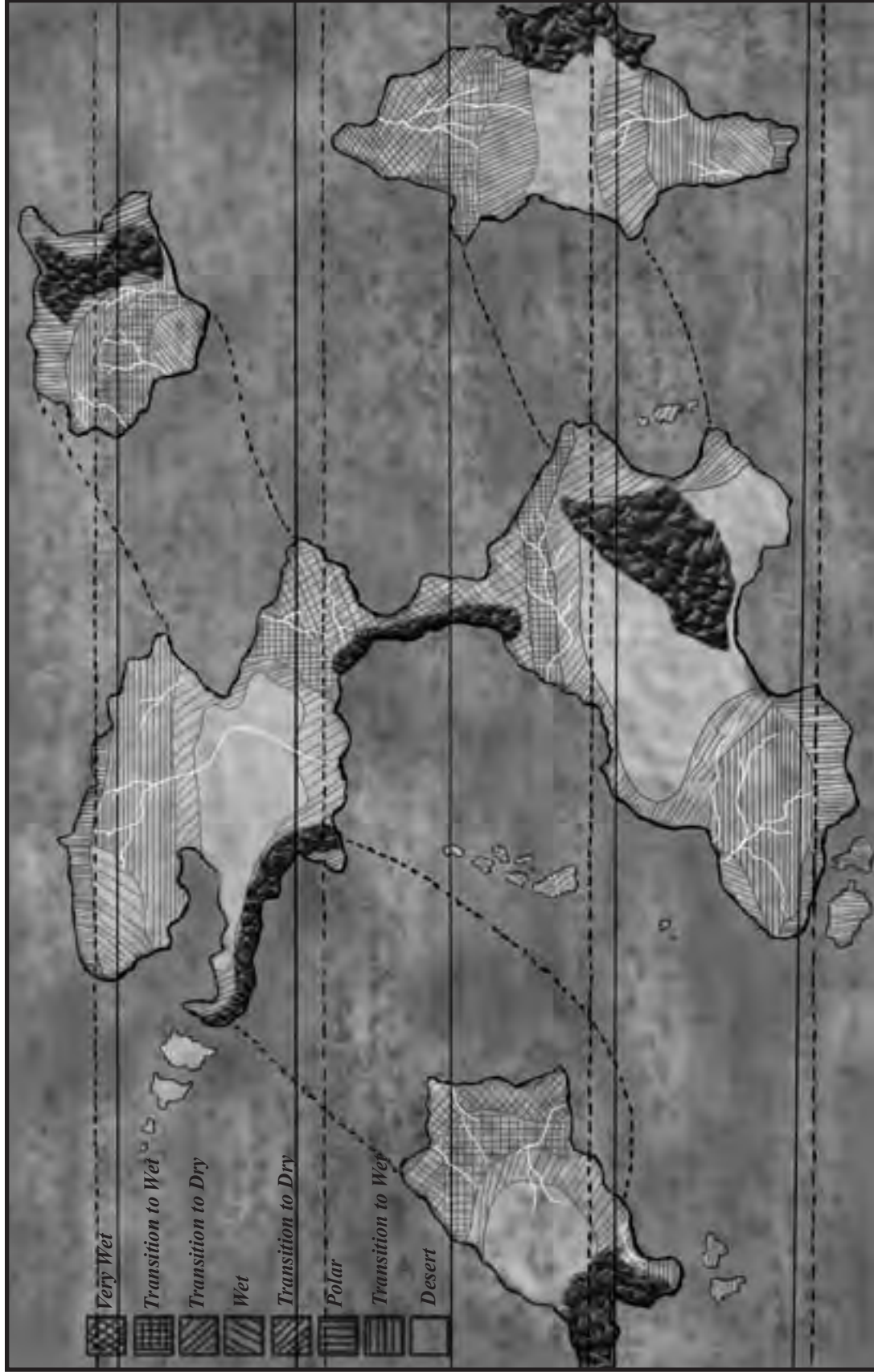
Placing the next wet areas was very easy. I just followed the wind patterns and land as I did with the equatorial wet zones. These wet zones aren't as wet as the equator, so if you find yourself faced by a large continent, the water won't travel as far inland as it would at the equator. I mapped my midlatitude wet zones, then placed my wet transitionals, and finally the dry transitionals. These dry transitional zones are mostly grassland/scrublands while the wet transitional zones are mostly forest/grassland mixes. The midlatitude wet zones can be temperate rain forests if there are mountains to catch enough rain, like along the Pacific Northwest coast. With all that done, I capped of my world with the cold zones north and south of the arctic circles. These zones can be grasslands, boreal forest, or tundra depending on their rainfall and how close they are to the poles. I haven't differentiated between the polar climates for this map, but by now, you should be familiar enough to place your taiga and tundra without guidance.

Next, I placed rivers on each continent, keeping in mind wind patterns and general elevation. Most of them are straightforward and not worth mentioning except for the major river on continent B that runs through the desert. This river provides water in the otherwise dry expanse and will no doubt play a role in intelligent creatures' interactions. It could also mimic the Nile as its headwaters are in wetlands. If I wanted, I could make these headlands have a particularly rainy period that would mimic the yearly floods of the great river on Earth. I think I will.



Mapping your World ~ Step 5





Mapping your World ~ Step 6

Interlude



"It looks so small from here." Kierian peered at the rotating globe marbled with ethereal clouds. "I've eaten roasts bigger than that."

"This is the macro prospective," replied Noj. The duo stared entranced.

"It is beautiful," Kierian conceded.

"They all are from this distance. There's a sort of symmetry and sense from this perspective," Noj answered nonchalantly. "Now we need intelligent races."

Kierian cleared his throat. "Yes, I was going to talk to you about that. You see I'm not very good with people." The goadling shuffled his feet. "I was the one who wasn't allowed to talk around others because they always took things the wrong way." Shifting his weight, he chuckled. "Once Delaine put a zone of silence on me because she was tired of hearing my 'silly' ideas. So I followed her around all day, and she was flapping her arms like a chicken and yelling." Kierian grinned. "At least I couldn't hear her complaining in the silence."

"I hardly see the problem," the gnome said in a slight tone of dismissal. He cranked the lever on the oily adding machine. "You'd be surprised how many gods don't really get along with people. Just think of them as creatures without fur, claws, talons, or ferocious bites—creatures that think. They'll ply their skills of survival, just as the falcon swoops and the serpent strikes." The assistant continued crunching numbers.

"Isn't that a bit irresponsible?" Kierian asked speculatively.

"Excuse me?" Noj replied over the noise of moving parts as he pulled the lever again.

Kierian paused to consider his words carefully. "I'm just saying, people have certain expectations of their creator. How would they feel if I spent more time figuring out how much biomass there is in a square mile of rainforest than I did on them?"

Noj stopped transcribing numbers, and a growing quiet fell on the room as he stopped pumping the machine. He removed his spectacles. "So you're saying you want to know more about people..." The sentence lingered as the gnome wiped his glasses on his soft undershirt. "Something like, if I may interpret your request, research intelligent beings and their behavior?"

Kierian shrugged his shoulders nonchalantly. "I think it's only fair..." Noj slid off his stool and placed his glasses on the end of his knobby nose. "I know the perfect place. Follow me." Noj stood in front of Kierian and did a full turn. A pair of thick double doors appeared before them.

"When do I get to do that?" Kierian asked curiously.

"When you become a member," Noj answered pushing the brass handles.

"Where are we going?"

Noj whispered, "To the library."

A head bobbed between two stacks of books piled high on the desk, stamping books and scribbling notes in ledgers. The unkempt halfling had a rhythm to his work. Open, pound, close, pound, scribble. Open, pound, close, pound, scribble. "Ahm," Noj cleared his throat loudly.

"Welcome to the Library of the Gods. Please deposit your belongings in a locker," the halfling recited by rote without looking up from his accounts. "And mind the books," he said with a bit more caution. "They are nervous today. New knowledge about." The halfling continued his work. Open, pound, close—

"Since when has Merrick the Tender not had time to welcome a guest of the library," Noj asked incredulously, "and an old friend at that?"

"Noj!" The surprised halfling climbed down from his desk and greeted Noj with a hearty shake of the arm. "You'll have to pardon the mess. It's been utter chaos since the knowledge of Verdium sprouted last week. A very



delicate time, you know. We've been pruning and clearing out the nonsense. It can greatly threaten the life of new knowledge." Kierian peered around the front desk to find fields of books, scrolls, and parchment. Neatly groomed in rows with stepladders, the library teemed with words, some spilling out of their books all together. Kierian walked along the long-extending rows. Every so often he'd see another halfling, taking books down, shelving books, grooming the stacks, and unless he was mistaken, one was fertilizing a section of papers.

"As I was saying, I have a godling in need of your assistance. He's preparing for the task and wants to brush up on the nature of intelligent creatures before populating his world."

"Oh certainly. I'll just need his personal information, and we'll register him in the system," Merrick replied cheerily pulling out some forms. The disheveled halfling searched his person for a pencil, finally unearthing one from behind his ear.

Kierian approached the librarian. "Do you know someone is spreading manure on a whole section of books?"

"Oh, you must be talking about Ketta in 'Grondelian Agricultural Studies,'" Merrick answered lowering his voice. "It's a bit of a pet project of hers. She tends to it every week. No one keeps memory for such knowledge any more. And who can blame them? Grondel sunk into the ocean ages ago." Merrick looked over the forms and handed Kierian a small card. "This gives you access to the stacks, and here's a map of the library by subject. I strongly suggest first-time visitors hire a guide and keep clear of this section." He crossed out a section in red ink. "Restricted access to librarians only."

Kierian studied the map as they walked toward 'Human Nature.' "They have an audio section!" the godling pointed out with enthusiasm. Noj's disdainful glance silenced that line of inquiry. The godling nodded toward the forbidden section as they passed by. "What's in this section?"

Noj whispered intently, "Poisonous knowledge."

Culture

Like water seeks low ground, plants seek the sun, and animals seek water, so too do intelligent creatures share common motivations woven into the very fabric of the multiverse. These common stresses, tendencies, and behaviors do not always manifest themselves in the same manner, but their similarities often outweigh their differences. Intelligent creatures that develop in similar environments often share similar adaptations, typically through shared information or through independent, parallel development. These adaptations to environment occur on three levels: genetic, physiological, and behavioral.

Genetic adaptations take the most time to develop due to the pervasive nature of the adaptation. Physiological adaptations are changes in how the body works without changing the very nature of the body. To understand physiological adaptations, consider two communities of the same species, one living in the mountains, and the other living in the lowlands. Though they are the same species, people living in mountains have a more efficient respiratory system as a physiological response to the oxygen-poor air. Now consider the difference between elves and dark elves. What originated as a physiological adaptation to underground living became a genetic adaptation with enough time and isolation. But behavior adaptation, the fastest method of acclimating to a given environment, is the greatest tool of survival for intelligent creatures. Often termed collectively as culture, behavioral adaptations include material objects, processes, and ideologies. They are the sum of everything people produce, do, and think, which is implicitly learned by every member of that society. Despite the unique nature of each kind of adaptation, all are driven by environmental stress.

As with every step of the creation process, the truisms presented in this chapter harness the inertial power of the multiverse rather than counter them with magic to sustain something “unnatural,” for lack of a better term. When you create something challenging this inertial state and do not support it with magic, it has a way of adapting and taking its “natural” place in the world. These truisms reflect a connection between environment and adaptation, but do not assert a simple causal relationship. Many elements develop together over time, and the results of such evolution are these truisms.

All this having been said, intelligent races are the most difficult part of your world to predict. Though they instinctually and unknowingly obey these truisms, their intelligence and ingenuity produce a wealth of possible outcomes. With this unique and sometimes damning trait of intelligence, we begin the discussion with common environmental limitations and their subsequent adaptations. From there follows all the decisive points of cultural development including subsistence patterns, material culture, technology, religion, and interaction within and between societies.

Intelligent Races

Every godling must decide which races inhabit their world. Though the typical array includes humans, dwarves, elves, gnomes, half-elves, half-orcs, halflings, and a sundry of goblinoids; that does not preclude the creation of new races with different distinguishing traits. Adequate intelligence is the only requirement for creating culture, intelligence’s brainchild for overcoming limiting factors of environment. Due to my own bias, I’ll use terms common to humans, though the principals expressed apply to other intelligent races.



Physical Elements

Environment is the ultimate determinant of a society's traits, either directly or indirectly. It is important to see the environment from a mortal perspective, and not from a divine perch. Each environmental trait limits the choices people can make in order to survive. It shapes their appearance, clothing, housing, demographics, social organization, and subsistence pattern. For example, not enough fresh water has its obvious drawbacks, but too much rain or rain at the wrong time of year destroy crops just as readily as drought. Forests hold a wealth of resources, but they must be cleared for permanent housing, farming, and animal husbandry.

When choosing a home for your new society, consider the physical limitations of their environment. Mountains; canyons; hilly, rocky terrain; swampy marsh; lack of wood; lack of pack animals; inadequate vegetation due to poor soil; insufficient or erratic rain; seasonal floods; large, wide rivers; man-eating predators; abundance of poisonous flora and fauna—all these factors determine how a society must adapt to survive. Rarely are these adaptations deliberate decisions by the society to better their chances of survival. They are usually "how things are done," and those with a selective advantage for that environment survive and pass their practices on to the next generation. The bulk of adaptive strategies are behavioral because intelligence creatures have the brainpower to manipulate their environment for survival. The most basic behavioral tactics are clothing, housing, methods of storing food for winter and times of stress, and culturally subscribed routines and habits that mitigate the hazards of the environment.

Appearance

Though each race has its own pool of physical traits that visibly distinguishes them, the environment imposes subtleties upon all creatures. Those living in warm, humid areas have darker skin coloring than those living in cooler, drier environments.



Inhabitants of especially dry areas often take on a yellow or reddish brown skin tone. Societies inhabiting warmer climates generally possess smaller body sizes and, their protruding body parts (e.g. tails, ears, bills, noses) are more prominent, which is why ice trolls tend to be larger than their swampy brethren, though their ears and noses are relatively smaller.

Temperate Lands

Temperate forests and grasslands are the base environments in terms of rainfall and annual temperature. These locations have agreeable climate for most of the year, and the biggest obstacle is securing enough food and warmth to survive winter. Temperate forests are ideal living conditions with ample wood, vegetation, and animals. With more rainfall than grasslands, temperate forests also have more sources of fresh water (rivers, streams, lakes). Strategies in temperate grasslands must account for less wood and water than temperate forests.

Inhabitants of temperate lands are generalists that adapt to numerous geological and climatic conditions. Since their environment is not extreme, their adaptations are the most varied, and their solution to any one condition is not as effective as specialists surviving in extreme conditions. In other words, they survive the winter, but not nearly as efficiently as someone living in the arctic tundra.

Settled groups have permanent housing and usually engage in food production. Wood is the favored building material, while skins, sod, and stone may also be used. Nomadic people have portable homes, usually skins or woven cloth draped over wood or bone frames. Skins and woven cloth provide the bulk of shoes, clothes, and other protective gear, while beads, feathers, stones, gems, and handicrafts decorate the society. Fishing plays a large role in societies living near rivers and coasts. Nomads store food by smoking, drying, or salting meats and fish and by storing seeds, nuts, and grains. They often use gourds, skins, and pottery for storing food and water. Hunter-gatherers and agriculturalists fare well in temperate climates. They often trade with other groups for the goods they need but cannot provide for themselves.

Deserts

Hot, arid, and windy, deserts are unfriendly places to life. Despite extreme heat during day, severe cold at night, and the scarcity of life-giving water, people inhabit the desert. It typically takes one to two weeks to acclimate to the desert, with the biggest problem being dehydration and loss of electrolytes. Unaccustomed to the heat, new visitors sweat too much to compensate for the sweltering heat and lose a lot of water and salts. Natives of the desert, however, have lower body temperatures and pulse rates during rest and moderate work, reducing the amount of energy and heat the body must mitigate. The ideal desert body is long and lean with low subcutaneous fat, increasing the surface area to weight ratio that promotes cooling.

The ideal clothing is loose fitting, loosely woven clothes with narrow openings for hands and feet, allowing evaporation and insulation from the elements. Layers of such clothing protect against wind and solar radiation. Sandals with soles that extend one inch in all directions are common footwear, while turbans, scarves, or other fabric covers the head and provides shade from the sun. Incidentally, minimal clothing is best for heavy labor because it allows for less heat and more evaporation.

Homes in hot, arid places are made of high heat-capacity material, such as adobe, mud, and stone, which absorb heat in the daytime and radiate it at night. These thick-walled, compact permanent homes are close together, sometimes wall-to-wall, to prolong heating and cooling of the entire unit of homes. Cooking fires are outside of homes to reduce heat, and some people build semi-subterranean homes. Semi-permanent homes rely on ventilation, often tents with parts that close during the heat of the day and open at night. At least one group forgoes all shelter and sleeps through desert nights as cold as 32°F huddled around a fire. By sleeping under their cloaks, with their feet toward the fire, and close enough to share body heat, this tribe creates a toasty 77°F microclimate.

Due to the dry conditions, most desert societies are hunter-gatherers, herders, or traders. The only places apt for agriculture are the rare desert rivers and oases, fed by underground fresh water springs. Hunter-gatherers receive most of their nutrients from



gathering nuts and vegetation, while successful hunts provide protein. Herders are semi-nomadic, traveling to seasonal grounds in search of water for their herds. Herding camels, sheep, goats, cows, or any combination of these, herders rely on knowledge passed from generation to generation on watering sites, cyclical patterns of catastrophic drought, and how to lead their herd and families to safety in those times. Herders often keep mostly female animals due to their milk production and periodically bleed the animals to gain sustenance without killing the animal. Traders risk the hazards of the desert to move goods around, providing money and other necessities for their families. Navigating by the stars, traders must move from watering hole to watering hole, survive the vicious sand storms, provide for their pack animals, and may spend up to half a year away from their families.

Rainforests

Rainforests are dim, steamy jungles packed with life. Like desert people, rainforest inhabitants have lower body temperatures and pulse rates during rest and moderate activity. Unlike living in the desert, sweating does not mitigate the heat due to the humidity of the rainforest. Natives tend to sweat less, and when they sweat, they lose fewer electrolytes than someone who is not acclimated. Though visitors can acclimate to the heat and humidity, it is more difficult than acclimating to deserts because sweat evaporation loses many of its benefits in rainforests. Many behavioral adjustments compensate for ineffectual sweating. The best clothing is less clothing, maximizing exposed surface area for sweat evaporation.

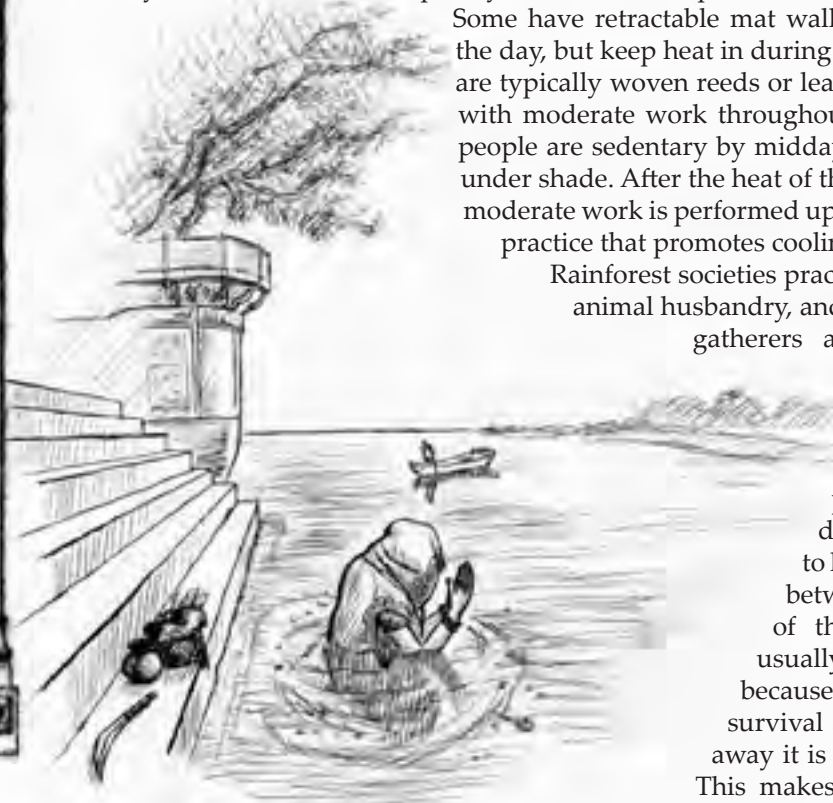
To escape the still, sweltering heat of the jungle floor, inhabitants build their settlements on a rise of ground near a water source to enjoy the small breeze that comes off the water. Houses are typically built with a wooden frame and a thatch or woven mat roof. Occasionally the floor is raised above the ground to provide more air circulation and keep rodents and snakes out. Some homes have no walls, easily releasing the heat of the day. Other homes are completely closed off to keep heat in during the chilly nights.

Some have retractable mat walls that roll up during the day, but keep heat in during the night. These mats are typically woven reeds or leaves. Work starts early with moderate work throughout the morning. Most people are sedentary by midday and stay indoors or under shade. After the heat of the day subsides, more moderate work is performed upon need. One cultural practice that promotes cooling is daily baths.

Rainforest societies practice hunter gathering, animal husbandry, and agriculture. Hunter-gatherers are usually nomadic

due to the nature of dispersal and cyclical blooms.

Plants bloom and produce fruit at different times of year to lessen the competition between species. Plants of the same species are usually highly dispersed because a seed's chances of survival are higher the farther away it is from its parent plant. This makes gathering food that



much more difficult. Hunter-gatherer societies living near coasts and rivers usually engage in fishing, which makes permanent settlements more viable. Animal husbandry typically revolves around pigs. Societies feed pigs their vegetative surplus, which isn't as easy to preserve as meat and grain. Pigs often become status symbols in such a society; more pigs equate to more surplus in a given family.

Agriculture in the rain forest depends on controlled burns. Known as swidden agriculture, these burns return the nutrients to the soil while killing fungi, parasites, insects, and pathogenic bacteria dangerous to crops. Crops are vertically layered, mimicking the typical growth in the rainforest and reducing the chance of crop-wide catastrophe. Roots, beans, grains, small fruit trees, taller palm trees, and giant cottonwood trees all grow in the same footprint, building up rather than across. This type of agriculture maximizes available water and sunlight while minimally taxing the rain forest. This type of agriculture also requires less effort on the part of the farmer because fewer trees must be cleared. After a few years of growth, agriculturalists begin another field and leave the spent soil fallow for secondary growth to take over (usually 7-10 years minimum). They tend to pick fields around their settlements, creating circles of primary and secondary growth around their villages.

Tundra and Taiga

Extreme cold, short growing seasons, and low biomass plague inhabitants of the tundra and taiga. People of extreme cold environments adapt in such a way to endure colder temperatures for longer amounts of time without suffering damage. Their bodies maintain their temperature even when their extremities are exposed to near-freezing conditions. Despite popular conjectures, arctic dwellers are not extra fatty. They are actually quite lean with slightly higher base metabolic rates and increased blood flow to their extremities. On a biological level, people of the cold are unique because they retain brown adipose tissue throughout their adulthood. This tissue, present in all babies and young children, allows people to warm themselves without shivering, expending less energy to maintain body temperature. Most people lose this tissue as they get older, but people of the arctic retain this tissue throughout their lives.

Active lifestyles, clothing, and housing are selective advantages cold-dwellers use for survival. Throughout spring and summer, inhabitants commonly perform all manner of strenuous activities like sledding, hunting, and sporting, thus using motion to generate heat. Clothing and housing create microclimates that keep cold-dwellers in relative ease. Clothing must insulate against the cold and release heat during strenuous activity. If heat is not released, sweat next to the body freezes, creating an icy blanket against the skin. Usually made from skins, furs, and (sometimes) traded textiles, layers of clothing create a functioning microclimate trapping warm air next to the skin. In the arctic, outer garments are waterproof and impermeable, while providing ventilation by widening the exposed area around the hands, feet, midsection, and neck. Expanding and contracting the openings with string binding determine the amount of ventilation. Dry grass insulates gloves, boots, and stockings while absorbing the moisture from perspiration. Warm headgear, either hats or hoods of parkas, is vital for minimizing heat loss.

Nomadic people live in tents made of dark-colored skins to absorb solar energy. Some consisting of 60+ skins, these large tents are double-layered, sewn canvasses that fit over wooden or bone frames. The use of inner and outer tents enhances insulation and creates dead space that warms cold, outside air before entering the inner tent. Permanent housing is usually made of wood, stone, sod, or sometimes ice. Cold inhabitants build semi-subterranean homes and/or cover their homes with sod or snow to insulate their microclimate. Semi-subterranean homes descend shallowly into the earth and lead into curved passages. Both the descent and the passageways reduce the amount of wind and cold air that penetrate in living space. After the passageway,





the house returns to ground level with warm air fed by fire and body heat. Ventilation holes prevent overheating while raised floors and skins along the ceiling and walls further insulate the family. Other people build homes above ground, but cover their homes with a heavy layer of sod for insulation and wind resistance.

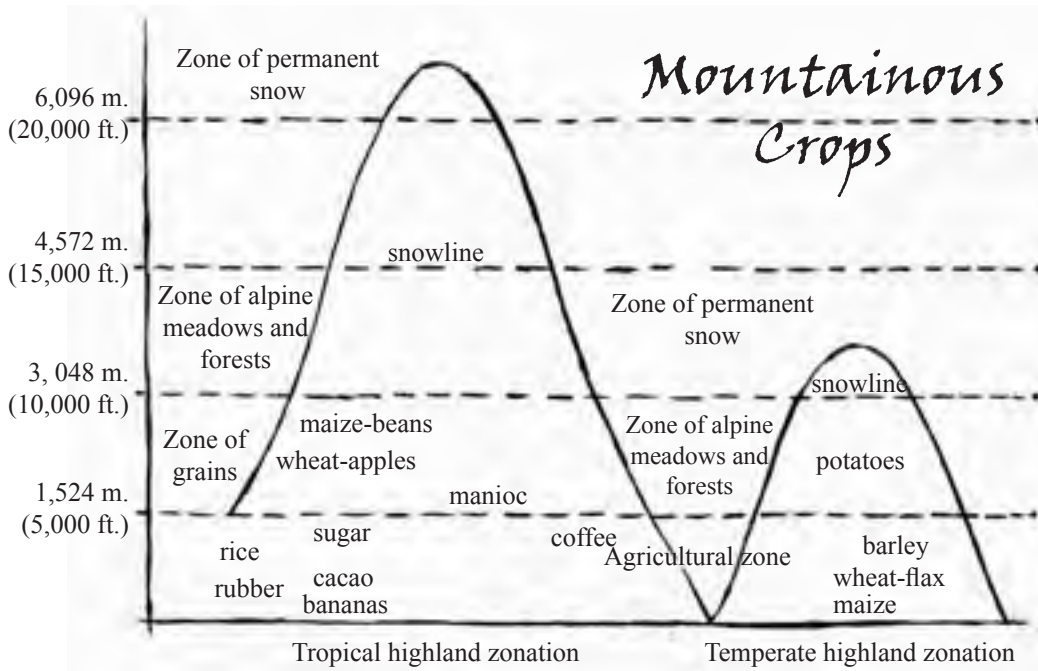
People living in the arctic also experience days of continuous sunlight and continuous darkness, which affects circadian rhythm and can lead to depression, mania, or serious disassociated states. Religious observances, feasts, and rites allow natives to socially cope with winter stress and days without sunlight. These feasts are often times of redistribution of goods to the needy, relieving social tension and reinforcing social bonds. People living in arctic tundra are hunter-gatherers. Elk (caribou), reindeer, birds, fish, walrus, seals, and the occasional small whale are the main food source of these societies. These animals are usually the only resource available to people of the arctic, who must trade for what they cannot make. In the taiga, there is enough vegetation for keeping herds and occasional minimal agriculture. The taiga forests also provide wood for building tools and homes, though many herders live in large tents with fixed winter quarters.

High Altitudes

Most societies live under 5,000 feet altitude, though there are those who live in mountains and high-altitude plains. The two main physiological barriers to high-altitude life are cold temperatures and low-oxygen air. The third is securing sustenance at such heights, where vegetation and animal life are severely reduced. Like other inhabitants of extreme, cold climates, high-altitude dwellers are not as susceptible to cold. Some mountainous people do not wear shoes or gloves though they work the fields in windy, cold conditions. High-altitude people also retain brown adipose tissue for non-shivering heat production, which most people lose after childhood. Clothing and styles of housing are behavioral adaptations to the cold. Wearing many layers of clothing insulate the body and create toasty microclimates close to the skin. Outer garments are tightly woven, dark heavy wool to absorb the sun's heat, while inner garments are loosely woven to encourage insulation. Besides skirts, pants, blouses, shirts, shawls, and vests, people also wear hats with wide brims for warmth and protection from the sun. Permanent homes are built out of piled stones or foot-thick adobe walls. Homes are built close together for shared heat, and sometimes they build communal walls that break the wind. Nomadic people live in tents made of thick skins or yak hair. At their winter site, they often dig sunken floors and construct walls to break the wind.

Elves in Rainforests

Though rainforests are full of life, that life depends on maintaining a sensitive balance. Every member (bacteria, insects, vegetation, animals) relies on the others for survival; overusing those resources can destroy this highly-specialized ecology. Elves as a race are long-lived and chaotic, two traits that are selective advantages for their favored home site. Elven societies, composed of long-lived individuals, have an advantage in foresight—their natural lifespan and collective generational knowledge often span over hundreds of years. Each generation must feed its people for centuries, making dependable and renewable food supplies necessary. Through the ages of adaptation, those which garner sustenance from their environment without damaging the forest beyond repair are the ones who reproduce and pass their cultural values to the next generation. Elves also have adaptations that limit their population density, ensuring that their needs do not surpass what they can take without disrupting nature's balance. Elves do not reproduce until after their first century, delaying fertility and population growth. Elves also tend to be chaotic, which usually produces less-dense societies.



Low-oxygen air cannot be so easily handled through behavior. People who receive inadequate oxygen to their tissue suffer the symptoms of hypoxia, which include headache, nausea, insomnia, and inability to perform normal tasks. Most visitors experience shortness of breath, hyperventilation, or some of the more serious side effects of hypoxia, but over time people adjust. Natives born and raised in

Dwarves Underground

Dwarves are a perfect example of how environment shapes a race. Carving a subterranean home in the very rock of your world, dwarves rely on sources of energy besides sunlight. Geothermal energy and sulfur-based life aside, underground ecosystems rely heavily on magirotrophes. In every part of underground food webs, the level of ingested magic increases. Dwarves metabolize this increased magic consumption to display their characteristic resistance to hostile magic. This may also explain their hardy nature, though some attribute it to their active lifestyle and cultural emphasis on warriors. Dwarves are also short, a big advantage when cutting your living space out of rock.

high-altitudes have physiological adaptations, namely the ability to take in more air without experiencing hyperventilation, more efficient methods of transferring oxygen to cells, and increased lung capacity. Some natives do not have these adaptations or lose them while staying in lowlands for extended periods of time. These unfortunate people often suffer from chronic mountain sickness, their blood thickens, and they must be bled every two or three weeks if they want to remain at a high altitude.

Inhabitants of high-altitude areas are typically agropastoralists, relying on crops, herds, and dung. On high plains, delineation of land is fairly straightforward, but mountains have vertical zones of growth that depend on altitude. The agricultural zone lies below 5,000 feet, where most people in the world live and staples thrive (barley, wheat, maize, and rice depending on climate). At 5,000 feet, alpine meadows and forests dominate, though cleared forests produce (depending on climate) potatoes, beans, manioc, and certain strains of wheat, maize, and apples. Snow often appears at 10,000 feet, though tropical areas still have trees and alpine meadows at that altitude. Beyond 15,000 feet is the zone of permanent snow.





Given these vertical zones, most mountain-dwellers seasonally travel to exploit as many resources as possible. Wintering in the lowlands (Do not let the name fool you. They are still really high up in the “lowlands”), the farmers plant staples and less tolerant crops in early spring while herders graze their herds at the lowest level of alpine meadow. As time passes and snow melts, the farmers plant frost-tolerant strains at higher altitudes, and herders bring their herds higher to new alpine meadows, uncovered as the snow melts. Besides the obvious benefits of participating both in herding and farming, high-altitude dwellers also have a valuable resource, dung. Used for fertilizer and dried out for fuel, dung is an important resource to those people who live in places with little to no wood.

Crops at high altitudes are subject to severe cold and relatively short growing seasons. One hardy plant that thrives both in the wild and as a harvested crop is the humble potato. The cold conditions lessen the number of fungi, parasites, and bacteria that prey on potatoes. One frost-tolerant strain planted late in the season in high altitudes is so impalpable that it must be sliced, dried, and ground before the bitter taste goes away, making it a good food store for winter. But even with these detractions it can be eaten, and other foods will not grow at the same altitude.

The herd provides meat, wool, skins, bone, and milk, preserved as butter and cheese. Herds usually consist of sheep, goats, or yaks, though llamas and alpacas are also herded. Sheep and goats produce milk for part of the year, while yaks produce milk all year long. Making cheese preserves excess milk that supplements the community's dietary needs in winter and times of scarcity.

Subsistence Patterns

Subsistence patterns are how societies feed themselves. They affect social organization, demographics, and available resources for housing, clothing, and crafts. Hunter-gatherers, pastoralists, and agriculturalists are the three basic types of communities, but they are not mutually exclusive groups. Though most races begin as hunter-gatherers, there is not an established evolutionary sequence from hunter-gatherer to food producer. Subsistence pattern affects how culture develops, and each subsistence pattern places different limitations on culture.

Hunter-gatherers have the lowest population density when compared to other types of communities. They live in small, nomadic communities, usually moving between established sites depending on seasons or climatic conditions. Hunter-gatherers' first priority is obtaining food. Because they obtain their food from diverse sources over a larger geographical area, they actually have more stable living conditions and rarely experience food shortages. The remainder of their time and resources goes into other cultural pursuits developing crafts, music, entertainment, religion, and rituals. Living in small bands with kin, hunter-gatherers rarely require or develop complexity in leadership, economics, and social stratification.

Pastoralists are food producers that rely heavily on their herds, consisting of domesticated large animals. Depending on circumstance, their herds may be different animal species or a single animal species. Sheep, goats, camels, yaks, cows, reindeer, llamas, and alpacas are the most common animals in herding. Pastoralists are typically found where soil is poor or climatic conditions do not favor growing food, making agricultural pursuits comparably less fruitful than herding. Most pastoralists rely on migration of the herd to provide enough grazing year round. Migration on mountains is vertical and in arid places from water hole to water hole. Pastoralists rely on every part of the animal. Milk, meat, and sometimes blood feed the community. Butter, cheese, dried, salted, or smoked meats provide winter stores for food. Manure fertilizes fields and gardens, and when dried, acts as fuel. Communities use lard and oil for many purposes, from fuel to crafts. Bones make bows, hand tools, tent frames, needles, crafts and ornamentation. Sinews make thread, innards make bags and

Home on the Range

Other large creatures may be candidates for domestication in your world. They must be mostly herbivorous with a wide selection of foods they can eat. They have to be efficient eaters, yielding higher percentages of meat and/or milk for the food they consume. Animals with faster growth rates are usually better candidates for domestication than animals that take a long time to mature. Animals with nasty dispositions or with a tendency to panic when people come close make poor herding animals. Animals with elaborate or particular mating rituals are difficult to breed in captivity, while animals that have hierarchies with dominate leadership and overlapping territories in the wild are apt for domestication.

inflatable rafts, and skins provide clothing. Many pastoralists gather food, trade with agricultural communities, or participate in some agriculture to supplement their diet and resources. Pastoralists usually have larger communities and support larger population densities than hunter-gatherers, though many continue a semi-nomadic lifestyle through their herd migrations. Pastoralists also have more organization in leadership and social relationships (especially with ownership and dispute resolution) due to the presences of herds.

Agriculturalists produce food by growing domesticated plants. Agricultural societies have at least one staple crop, usually a grain or a tuber, and the most successful have two, which produce a protein when combined. Many agriculturalists supplement their diet with gathering, hunting, and animal husbandry. Agriculture originates in places where many potential domesticates are present due to ecological diversity over a relatively small area. Agriculture spreads from these centers in waves, taking root where growing food is more productive than other methods of subsistence. Geographical and ecological barriers may retard or prevent the spread of agriculture due to difficulty in migration or the unsuitability of the original domesticates in a different climate. There are many stages to agriculture, from the proto-garden to intense, commercial endeavors. Regardless the intensity of the farming, agriculture establishes two facts: the society is sedentary, and the society makes more food. A sedentary society requires a smaller geographic area to derive its sustenance and de facto has a higher population density. The society that makes more food will have a larger population. This is not a simple cause and effect, rather an autocatalytic process where rise in food production and rise in population propel each other in a cycle that intensifies as it continues.

Effects of Agriculture

These basic byproducts of agriculture often create more autocatalytic processes giving greater complexity in leadership, economics, and social stratification. In small kin-based societies, decisions are usually made as a whole, without a defined, visible, office-holding leader. Most internal conflict occurs between kin, and other members of the society apply social pressure to resolve the conflict peaceably. Social stratification is minimal since everyone is basically doing the same thing-acquiring food. Hunter-gatherer economies are much simpler because there are no specialists or full-time craftsmen, and nomadic/semi-nomadic societies are on the move and travel light. They do not make or collect many material goods. Compare this generalized view of hunter-gatherers to agricultural societies. Sedentary living permits people to collect things without thought of having to move them constantly. Food production and surplus make it possible for a society to support non-food producing individuals, which fuels craftsmanship, inventors, political leaders, and religious offices. Engaging in agriculture creates a seasonally pulsed labor force, which may be employed for public works like temples, monuments, irrigation, and dams.





As this physical complexity develops, social and political realms evolve with greater complexity. As societies grow, communal decision-making becomes difficult, and power gravitates to a central, decision-making figure. This figure becomes the arbiter in internal conflicts (which become more frequent as societies grow beyond kin-based communities) and the spokesperson for the society in external conflict. As the centralized figure welds more power and responsibility, other figures and offices evolve creating a bureaucracy. This centralized power may employ public works, organize food production to support the dense population, and pool the resources of the entire society into his vision. When agricultural surplus frees members of the society from producing food, social stratification intensifies because everyone is no longer doing the same thing, wielding the same power in decision making, and owning a sparse collection of goods. A discrepancy of wealth from occupation is the oldest line of social stratification.

Though agriculture is the cause of all that bards and poets hail as marvels of civilization, it is here that I must insert a cautionary tale. At some point, a civilization reaches maximum food production without an end to population growth. Sometimes the soil's fertility is spent after centuries of continuous cultivation. Sometimes a people deforest their environment and destroy their soil through increased salinity. Other times food production is moved outside the original settlement, which has since urbanized. With disruption of trade, densely populated capital cities brew hungry, discontent factions that rip the civilization apart or weaken it from within for invaders to plunder. Uncontrolled population growth is often a key factor in a civilization's downfall.

The limiting factors to agricultural intensification are environment, technology, and social organization. Some environments are less conducive for agriculture. For example, rainforests must be cleared and burned before agriculture can take place. Rainforest inhabitants have a limited space in which they cultivate without disturbing the forest and hampering secondary growth. In addition to these considerations, swidden agriculture generally does not produce high yields compared to arable soil. But despite these limitations, agricultural societies flourish in the rain forest. Inadequate technology also limits the extent and productivity of agriculture. Some thick, fertile soils require heavy plows before they become arable. Other places require greater organization before agricultural pursuits are viable, like places with erratic or inadequate water. Once people band together and organize their efforts, wells, dams, and irrigation ditches turn ground into fertile soil. But even with these behaviors, some soil is simply not suitable for agriculture, and raising crops never outcompetes herding, hunting, or gathering.

Material Culture

Material culture consists of everything a society makes and is strongly influenced by environment, subsistence pattern, and societal development. Environment determines the raw materials available for building and craft making.

Ambling Towards Domestication

What steps led hunter-gatherers to separate stock from wild strains, control its reproduction, and consequently create mutualistic relationships between man and his environment? Agriculture begins with hunter-gatherers who have semi-permanent homes or sites. Being messy and disruptive, they break up the soil when they create settlements, excrete waste, and disseminate the seeds of their main food supply. From here they take tedious baby steps towards agriculture as they throw seed of preferred plants on the ground, aerate the soil, burn away brush to clear the ground for their favored plants, select species that produce more seeds, and create technology to aid agriculture. Though this process seems simple and intuitive as an afterthought, it can take millennia to develop.

Communities living near forests use wood in house construction, while communities on the tundra rely on bone, skins, and snow. Communities in hills and mountains are more likely to develop metallurgy than communities in the rainforests, where heavy rains continually leech the soil. This prevents minerals from depositing and prevents metals from being easily available on the surface. Subsistence pattern determines how many and what type of crafts a society makes. Wool, felt, and furs are more likely to clothe pastoralists, while textiles develop in agricultural communities, usually growing cotton or flax. Hunter-gatherers travel light due their nomadic tendencies, making their few crafts light, easy to move, and multi-purposed. Societal development determines the amount of resources available for making and trading crafts; more complex societies usually have more wealth, resources, manpower, and trade contacts.

Most crafts concern food, clothing, or shelter. Though crafts typically serve a purpose, there are other forces that shape the appearance and function of society's crafts. As societies become more complex, their crafts and buildings become more complex, specialized, and ornate. This is partially due to sedentary societies who have the luxury of filling permanent homes with useful and decorative crafts. The growing complexity of social stratification also promotes the collection of goods while agriculture supports more full-time specialists. Mirroring the growing complexity in other facets of agricultural societies, their crafts become more specialized and ornate. Rather than have an all-purpose basket, members of more complex societies may have indoor baskets and outdoor baskets, or many baskets, each with one specialized purpose. To visually accentuate this specialization, crafts take on different materials, shapes, colors, or designs. These differences may be solely decorative, but they are often also functional. For example, baskets designed for picking fruit may hang over the body, while baskets for transport are designed for carrying on the head.

Food Crafts

Food crafts are objects that gather, store, produce, process, preserve, and cook food. Food crafts vary depending on available resources and climate, but they fulfill basically the same purposes. The most common crafts store food and water, such as baskets, sacs, trays, and jugs. Made from wood, animal innards, pottery, woven reeds, bamboo, straw, hollowed gourds, and carved stone, these containers find use in the simplest of societies. More complex crafts emerge to increase the amount to food, including weapons for hunting, digging sticks for unearthing tubers, tree-climbing ropes, fishing hooks, and nets. Tools invented for food production are numerous and varied. Pastoralists create lassos to capture animals for herds, churns for making butter, containers to pack cheese, and more ways of preserving/cooking meat, milk, and blood. Farmers have the most accoutrements by far: hand tools for planting, weeding, winnowing, and threshing; plows for breaking tough ground; harnesses for plow animals; grinding machines; storage to keep grains dry; and cutting devices for picking fruit, to name a few.

Many other materials and crafts come from food crafts. Consider how much straw a farming community has after harvest, or how much skin, bone, and tendon a herding community has after slaughter. These "leftover" resources spur the development of other crafts when a society has enough surplus food to support specialists. Another consideration is how food crafts and methods affect other crafts. For example fire starters, originally only used for warmth, become a tool in cooking food. With time that technology may spread to baking bread, firing pottery, or working metal through the development of vents and bellows. After all, weaponry is just an offshoot of improved hunting/processing tools turned against intelligent races.





Hand Spinning



Clothing Crafts

Clothing crafts include all the accoutrements involved in making clothes. The first clothes are animal skins, skinned with stone tools, sewn together with tendon thread and bone needles. Animals prized for their warm fur or water resistant skins are elk, deer, bear, beaver, otter, and seal. More complex clothes require more crafts for production. Herders keeping sheep and other woolly animals invent crafts for combing and spinning wool or compacting lint into felt while those who wear leather develop tanning methods. Communities with wild or cultivated flax, hemp,

cotton, or other such vegetation invent crafts for processing, spinning thread, weaving, and sewing techniques. There are other alternate sources of clothing. At least one tribe beats bark until it is soft enough to sew, another extracts silk from worms, while a third makes water-resistant cloaks from bird feathers.

Though people use clothing as protection from the elements such as rain, sun, wind, or cold, it isn't long before people decorate clothing and add accessories to visually advertise their social status. Sewing techniques, different styles, unique garments, patterns, dyes, stamps, embroidery, beading, and fasteners accentuate plain clothing. Like other pieces of material culture, clothing crafts become more specialized and diverse. Due to larger populations and more complex social stratification, physical appearance becomes an immediate indicator of status. In some societies, married women wear different jewelry and clothing than single women, or important events and holidays have affiliated attire. Sometimes clothing designates members of the same profession or society. Most often clothing speaks to the wealth of an individual. Certain raw materials are considered more valuable due to strength, durability, texture, color, rarity, or design, and only wealthy people can afford such clothing.

Housing Crafts

The tools and materials with which people build homes and the furnishing within the home constitute housing crafts. Intelligent races make homes in every environment: underground, in caves, on water, in trees, and in cliff sides. The ingenuity of building materials knows no end: mud, wood, straw, bamboo, grass, reeds, rocks, canvas, and skins comprise most housing. Portable homes are usually sown canvas or skins stretched over a wooden or bone frame. They can be small affairs or large tents housing dozens of people. Using two tents and stuffing insulation between them keep inhabitants comfortable. Permanent homes vary depending on the available resources. Adobe, wattle and daub, sod, and bricks are good building materials for societies short on wood and stone, but plentiful in dirt and straw. Other homes have a wooden or bamboo frame lashed together, either in a rectangular or circular configuration. Thatch (dry straw or grass) and woven reeds are fairly water resistant walls and roofs. Some homes are stacked stones or stone and mortar, while others carve homes out of rock in cliffs or tall stone towers. Societies even make homes on water, lashing boats and rafts together, making "land" out of woven reed mats, or building homes on stilts. Homes reflect the environmental challenges in their construction. For instance, homes are

often built in stilts in area with frequent flooding. People living in hot, dry areas often build adobe housing complexes with shared walls to slow heating during the day and retain heat at night. Homes in cold areas with high winds are sometimes sunken into the earth or covered with sod.

Along with the actual structure, people make crafts to fill their home. Homes often have some sort of furniture, storage, and lighting. Like food and clothing crafts, homes and their wares become more decorative and specialized as societies grow in complexity. Nomadic societies keep these crafts simple, easy to move, and multi-purpose. Household crafts may be no more than a woven mat that rolls up easily, a generic woven basket, and a nightly fire for warmth and light. With permanent housing comes more household crafts with more specialized uses. Sparse multi-purposed, single roomed homes become larger and partitioned. Spaces and rooms acquire specific purposes, such as bedrooms for sleeping and kitchens for cooking. Furniture expands to beds, tables, stools, and pillows. An assortment of boxes, pots, jars, trays, and baskets hold their belongings, while shelves and cabinets designate space for storage within the house. Torches, candles, lanterns, lamps, braziers, and fireplaces warm and light homes, while craftsmen invent even more goods to fill homes.

Transportation Crafts

Transportation crafts are goods that move things around: carrying carcasses after a hunt, moving crops from the field to the settlement, carrying babies while continuing work, and moving goods for trade. The earliest crafts for transportation rely on manpower and sometimes doubling as storage containers. For example, a walking

Pottery

The science behind pottery begins with clay. Because of clay's plasticity and its ability to keep its shape upon drying, clay pots become one of the primary crafts in sedentary societies. Another reason for pottery's popularity is the accessibility of clay, a common material found in numerous environments. Most clay is red or brown with lots of impurities, while white clay, used to make porcelain, has substantially fewer impurities. Working and pulling the clay produces stronger pots by releasing trapped air and some impurities. Potters employ various methods in making pots. The coil method starts with a length of clay (like a snake), twisted and stacked into shape and smoothed down. Some start with a lump of clay spun on a rotating wheel powered by foot. Working with the circular motion of the rotating wheel, potters use their hands, shells, sticks, and other tools to shape and etch the pot.

Different types of fuel and kilns also develop as crafts become more prolific. The first pottery was likely fired in open pits fed by dung or wood. As pottery develops, potters invent closed kilns insulated with wood and charcoal, increasing kiln size and temperature through insulation. Plain earthenware vitrifies at 1800°F, while stoneware and porcelain (very white stoneware) hardens at 2300°F. The addition of chimneys and vents allow potters to control the amount of oxidation in firing, which greatly affects the coloring of the pottery.

With increasing societal development and technology, potters embellish their pottery with colors, glazes, and designs. Most coloring agents in pottery are ground minerals, commonly copper, cobalt, or iron. Copper creates greens and blues, cobalt blue, and iron can produce almost any color when used in the right amount, ground to the right size, and added to the right base. Glazes add a finishing sheen to raw pottery. Glazes are substances glossed on pottery that melt at low temperatures compared to pottery's hardening temperature. Early glazes are clay blends, while later technology incorporates ground glass. Potters also add ground minerals to color glazes, carefully guarded secrets among craftsmen. Besides coloring and painting designs, potters also add decorative pieces onto the surface of pottery, known in the trade as sprigging.





society without draft animals may move liquids in round-bottomed pottery designed to balance on the head. Upon arrival these pots rest on a stand, keeping the pot stable despite its rotund shape. Societies with domesticated or tamed draft animals have more transportation accoutrements. Harnesses, saddles, and yokes make animal power accessible to societies. Hauling supplies, carrying people, and plowing fields are the most obvious uses of draft animals. Not all large animals make appropriate draft animals. The most common mundane draft animals are cattle, horses, yaks, water buffalo, oxen, camels, and elephants. With these animals come crafts for taming, birthing, feeding, grooming, healing, riding, and decorating them.

Public Works

Public works are buildings or projects undertaken with the pooled resources of a society. From mounds created by moving vast amounts of dirt to towering monuments, public works are structures that require great amounts of resources and manpower. These projects do not usually occur until societies settle into permanent sites. Though it is hotly debated whether need for such projects sparked the beginning of governmental institutions or such institutions predate public endeavors, the fact is that the two are interrelated. The presence of public works attest to the complexity of the society. Larger projects require more resources, people, wealth, surplus food, and a developed, centralized governmental machine to allocated them. Some public works improve the condition of society, such as irrigation systems, sewers, and defensive structures. Others further support the institutions of the centralized power, such as temples, palaces, housing complexes, and tombs. Some leaders envision monumental works that attest the greatness of their people.

Entertainment Crafts

Entertainment crafts are those things that societies create to stave off boredom, an inevitable byproduct of intelligence. Even the most basic societies have periods with nothing to do, so people invent ways to pass the time. The most common crafts associated with entertainment are games and musical instruments. The most basic games began with items found naturally: stones, sticks, shells, nuts, and other debris. People fashion pieces for amusement from available resources according to their environment and subsistence pattern. Societies make tiles, dice, marbles, and cards from carved stone, wood, and ivory. Thick shells and gourds make good cups for catching or throwing small objects. Hunters and herders make dice from knuckles, teeth, and carved bone and balls from inflated bladders. The more societal complexity, the more complex their games and specialized their toys become. Games acquire particular pieces and parts with unique attribute while goals and rules become more intricate.

Dyes

Color is a precious commodity. Through countless trial and error, societies use elements from their environment to dye textiles, paint wood, glaze pottery, and decorate their bodies. Predominately used for decoration, colors quickly become status markers, both in quantity and quality. The most common sources of color are vegetable matter. Barks, roots, flowers, fruits, resins, gums, nutshells, and saps provide various hues. People also make dyes from animal secretions, dried insects, and ground minerals. People mix these colorants with other substances to make the color stick. Potters mix colorants with other clays or pieces of glass. Textile dyers use chemical solutions (mordants) before, during, and after dyeing to ensure color fastness and control the hue. People mix colorants with oil or lard to paint their faces and bodies. Fruit pulp (mixed with organic acids) dyes hair, while painters use binders (e.g. egg yolk, linseed oil, milk) with their colorants.

The same is true of musical instruments. Basic musical entertainment may only require singing, chanting, or rhythm from natural objects, like clapping hands or beating hollow logs. Societies produce musical instruments from a broad list of materials, including wood, bone, stone, metal, clay, gourds, tendons, and animal guts. Many of these material resonant when agitated, making them self-sounding instruments. Though each material and its specific use generate a different sound, there are basics types of instruments. Most basic are rhythm instruments that make no specific tone, like drums, scrapers, and beating sticks. Some rhythm instruments also have melody, like chimes, xylophones, and tympanis.

Some instruments are powered by breath. Flutes (e.g. panpipes, duct flutes, and recorders) are hollow tubes with a mouth-hole, played when air passes over the mouth-hole. Reed instruments (e.g. clarinets, zummara, bagpipes, oboes) use a single or double reed instead of a mouth-hole, creating a shrill tone with a woody resonance. Horns and trumpets sound when player's lips compress and control the air flowing through the instrument. Though many associate metal with horns and trumpets, ivory, seashells, and animal horns are also played in this fashion.

Stringed instruments rely on the natural resonance of materials under tension, typically plucked, strummed, or bowed. Cavernous chambers are sometimes added to amplify the natural resonance of the taut string. Strings are made from animal guts, tendons, and metal, while their chambers are predominately made of wood. Stringed instruments may be the last instruments in the development of music, due to the complexity required for the simplest of musical bows. A few examples include bows, harps, lyres, lutes, fiddles, pianos, mandolins, and zithers.

It may appear that I have spent an undue amount of time on entertainment crafts, but only because entertainment is so vital to mortal existence that few societies live without it. Many societies attribute music and games with high importance, so that certain songs and games are performed on important occasions, or in celebration of life events. Each society has its own sound, its own song, and its own way of entertainment that speaks to the root of all it values. To find its song is to see into its very core.

Ornamentation

Ornamentation is a pervasive occurrence in all societies; the desire for ornamentation is strong in even the most basic cultures. In early egalitarian societies, decoration mirrors the reoccurring themes cultures interact with. For example, farming societies may embellish with representations of crops, blooming trees, and other agricultural elements, while horse herders use braids and twists for decoration, commonly used in horsehair crafts. These representations may come to symbolize larger ideas, such as fecundity, renewal, and cultural pride.

As population increases, egalitarian societies (where leadership is not clearly defined) centralize power into individuals and offices. Increasing wealth and social discrepancies among the society intensify social stratification. Ornamentation becomes the first visible cue denoting an individual's wealth and status, indicative of their reproductive fitness. As the need for differentiation increases, so does complexity in ornamentation, which permeates through all parts of material culture.

Though each culture has different styles and techniques, certain truisms can be ascertained. Ornamentation as a visual cue for distinction relies on rarity. Perhaps the materials themselves are rare, such as shells, minerals, metals, dyes, and stones that are scarce or not locally found. Sometimes techniques and technology require an unusual level of mastery, and few (if any locally) can produce the ornamentation. Lastly, social pressure limits who can wear certain ornamentation, such as jewelry only married women can wear, or a style of clothing reserved for artisans.

There are three basic types of ornamentation: those applied to the body, those applied to other crafts, and those that exist solely for decoration sake. Body



embellishments include piercing, scarification, tattooing, and painting. Locations, colors, patterns, and degree of coverage vary from culture to culture. Dressing up possessions take on many forms: carving wood, scorching leather, engraving metal, dying textiles, painting furniture, embroidering clothes, stamping fabric, embossing paper, lacquering boxes, and bejeweling daggers. Some objects become so ornate that they lose their functionality, like ceremonial jade knives or lace gloves. Lastly, there are those items that have no purpose but to be beautiful and striking, such as sculptures, paintings, drawings, woodcuts, carvings and ornamental gardens.

Technology

People tinker. This is the beginning of all technology. At any particular moment over a large enough area, some part of the populace is being inventive. Technology is another autocatalytic process, wherein technological advances spark more advances. This self-driven process relies on two truisms of innovation. First, any advances depend on mastery of simpler, basic problems. For instance, a society cannot have pottery or metallurgy without proper technology for creating hotter fires. Second, new technologies arise from the recombination of materials and methods. Introduction of a new material or a new methodology spurs more technological innovation by simply recombining them with known materials and methods. Therefore the key to technology is not inventing new items and methodology (people will always tinker), but rather getting societies to accept, use, and maintain technology while gaining exposure to new ideas for further technological advancement.

Social Factors

The main factor in technology is geography and subsistence pattern. All things being equal, technology develops fastest in large productive regions with large populations of intelligent races, many potential inventors, and many competing societies. Of course, all things are rarely equal. The primary prerequisite for determining a society's technological level is sedentary societies producing surplus food that supports would-be inventors, but it is also a question of when food production began. The earlier a society begins food production, the longer it can support full-time specialists and create more innovations.

Barriers to diffusion are one aspect that deters technological advancement. Geographical barriers, like especially rugged mountains, oceans, and narrow isthmuses, impede the movement of people, and de facto the spread new ideas. Ecological barriers such as changes in latitude or drastic changes in climate and ecology slow technological advances for the same reason. Borrowed technology spreads much faster than independent innovation, and these barriers to migration effectively isolate certain areas and the societies that live there. The distribution of intelligent races is another possible technological deterrent. Some continents just don't have many people or have dispersed societies. Without exposure to different ideas and many nearby competing societies to encourage adopting potentially advantageous technology, societies are left to slower, independent invention.

There are other social factors that affect technological development. Long life expectancy gives possible inventors more time to create, as well as encapsulate a greater array of knowledge within a single generation. Cultures that support technologies by creating and then teaching them to the next generation are more likely to maintain technological knowledge on a cultural level. Societies with a scientific outlook, risk-taking behavior, or tolerance of diverse views (opposed to strongly traditional societies) are more likely to invent and adopt new technology. Literate cultures also have an advantage because they can preserve their knowledge and use that of previous generations.



Selling Technology

Like all other things, technologies compete for survival through adoption and maintenance by societies. Cultures are more likely to adopt innovations with easily observable economic advantages in comparison to current technology. People also support technology that promotes social prestige, which explains the vast resources allocated to ornamentation and craft specialization. Lastly, societies adopt new technology more readily if they do not counter other vested interests. For example, the royal construction foreman, whose cousin makes bow drills for a living, strongly discourages using new hand drills in his projects, even though they may have a technological advantage.

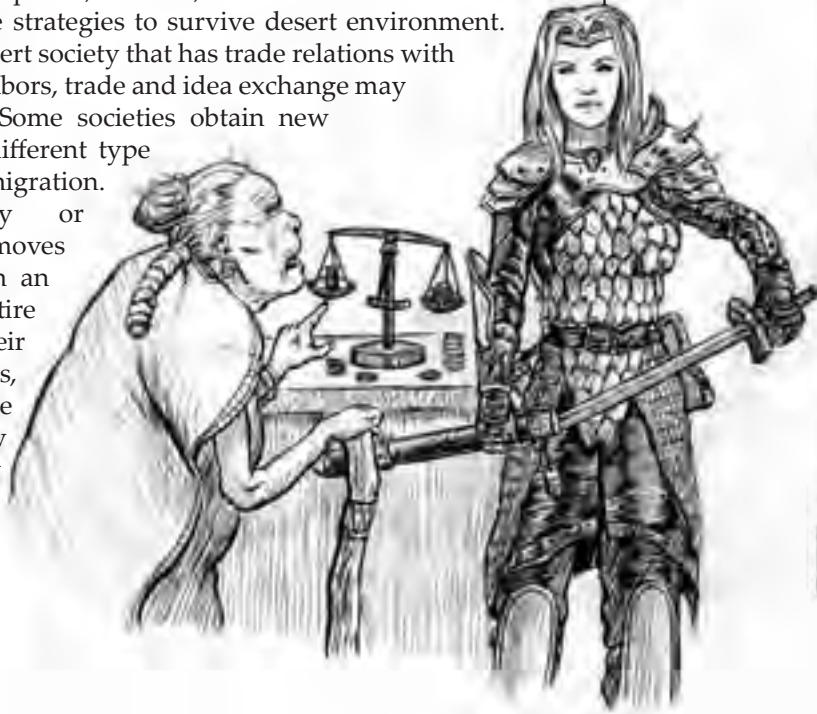
The first stage of adoption is accepting the technology. Once new materials and methods garner tacit acceptance in a culture, people explore possible uses of the imported technology. Sometimes local applications stray far from their intended purpose. Some societies import the technology without ever developing it locally. Some may have a paucity of inventors due to lifestyle, others may have not mastered the prerequisite skills for local manufacture, or political forces may close the line of inventive inquiry. Then there are those societies that maintain new technological knowledge through local production and combining new technology with established materials and methods. Technology survives in societies that use, produce, and teach them to following generations. This is especially true of craft techniques, where materials and method are highly-guarded secrets passed only to apprentices.

New Technology

There are three ways to obtain new technology: trade, emigration, and espionage. New ideas and technology disperse through established trade contacts, making the movement of ideas directly tied to the movement of people and their wares. People and their ideas are more fluid on continents whose main length is east/west rather than north/south. Staying within the same general latitude (which determines length of day and influences rainfall and climate) causes less stress to migrating plants, animals, people, and the exchange of ideas. Geographical barriers and drastic ecological changes hamper the movement of people, such as two temperate areas separated by a vast desert. In that instance, the desert deters exchange between cultures on either side of the desert because plants, animals, and societies accustomed to temperate climate have not evolved the strategies to survive desert environment.

Should there be a desert society that has trade relations with both temperate neighbors, trade and idea exchange may proceed with ease. Some societies obtain new technology from a different type of movement, emigration.

Whether voluntary or coerced, emigration moves people around, from an individual to an entire cultural group. Their food, animals, crafts, and technology are all potentially new to whomever they encounter in their migration. Espionage is covertly obtaining information from an outside source



without knowledge or approval of said outside source. Whether obtaining the seed of a valuable fruit, the location of a silver vein, or the type of weapons another society uses, espionage is as old as conflict itself. Acts of espionage typically root from martial conflict, economic gain, or competition in cultural advancement.

Societies typically borrow technology in two methods. One method begins with obtaining a complete picture of how things work and then emulating the design. Once a society understands the emulation, they can modify the technology for their purposes. The other method is the simple spread of ideas; it takes a very small thing to spur people to tinker. Partial, incomplete information about a new technology reaches a community, which in and of itself can inspire invention. Technology is not limited to crafts; it may also encompass crops, domestic animals, languages, writing/alphabets, philosophies, religions, governmental structures, laws, sciences, and the arts.

Development of Magic Use

Magic is everywhere. Certain creatures develop the ability to convert magic into sustenance or into supernatural abilities. Some intelligent races evolve physiological adaptations to magical geography, but most pay little heed to the ambient magic around them. People learn to use magic in their quest to manipulate their environment for survival. Like technology, intelligent beings invent new ways to use magic and how to accomplish different effects. Unlike technology, not everyone can manipulate magic to produce desired effects.

Intelligent beings first harness the body magic through performing rituals and projecting their collective energy into accomplishing small, simple effects. These first effects are typically sporadic, inconsistent, and unreliable. They know that certain objects, words, actions, and concentration allows them to harness magic, but they do not know the exact components and combinations. The next leap in magic use is individuals that direct magic. These proto-spellcasters use their force of character or unconscious congruity with the multiverse to channel ritual energy into more-developed effects. Though intelligent beings' use of magic is limited at this point, they now know certain individuals have the ability to concentrate and direct magic, some better than others.

The first casters are most likely adepts and bards. As prevalent as entertainment is in all societies, bardic abilities do not go unnoticed for long. Adepts (proto druids and clerics) discover their ability to use magic through their healing effects, always a need for a community's injured and sick. From there, cultural diversity plays a large part in how societies develop magic use, depending on the level of social complexity, temperament, cultural mores, and exposure to other societies. Hunter-gatherer societies may be the first to develop spellcasting rangers, while clerics of seafaring societies may only develop air, luck, travel, and water domains. Agricultural societies may develop druids before clerics, and only through urbanization do clerics become as prolific as druids. Communities of desert traders may use stars and astrological objects to channel magic and may be the first communities to discover create water. Highly stratified societies, which depend on communalism over individualism, may not produce sorcerers, while some societies may shun magic use for its unnatural results. Thus, it is gross mistake to think that all types of spells, spellcasters, and spellcasting are available to all societies at the same time. Magical knowledge spreads much like technology, through trade, emigration, or espionage.

There are two points of consideration. First, magic is a resource, and you can always over exploit a resource. Second, the body magic is sentient with its own will. As great civilizations grow, produce more spellcasters, and manipulate more magic, their will greatly overrides the will of the body magic. This "unnatural" manipulation of magic on such a large scale often agitates the body magic, which treats such behavior like an infection. The body magic has many ways of righting itself. It may lend its might and favor to less-advanced enemies of the civilization or incite war between many magic-using societies. Both bring the downfall of spell-using societies, and bury their



knowledge under ruins. The body magic may bombard the infection with a plague of magiovores, leaching away (or cleansing the area, depending on your perspective) the society's magical resources. Other times, it may simply redirect magic. One day, spellcasters cannot cast their highest-level spells, magic knowledge is disappearing from their records, and once-magical items become mundane trinkets. Sometimes the body magic takes a longer path and renders the transfer of magical knowledge impossible; suddenly teachers cannot teach their students, for their students cannot learn.

Ideological Culture

Ideological culture is a society's beliefs and practices. Unlike material culture, these things are intangible, yet reflected in every societal aspect. Natural instincts promote current survival with little to no thought beyond present stresses. Intelligence creates temporal awareness, giving intelligent races tools to overcome their short-term survival instinct. Certain practices, beliefs, and taboos develop within the community that increase the long-term survivability of the community, and the survivors pass these customs to the next generation. In this way, ideological culture is merely an intelligent adaptation to the environment, furthering the survivability of the community. For example, when you create a successful society living in the desert (which cannot support large, densely-populated groups), create cultural practices that retard population growth. Delayed marriage, long nursing of children, sexual taboos limiting the times and conditions for copulation, and martial pursuits that regularly prune the community are a few ideas.

Creating cultural beliefs and practices would be much easier if intelligent creatures were not conscious, introspective beings. The benefit and burden of intelligence manifest in the urge to constantly fiddle with things while promoting the status quo. In this unconscious pursuit, societies create cultural practices that are selective advantages, and they also create many with little to no benefit. As these adaptations pass from generation to generation, societies develop a special reverence for them. From a mortal perspective, ideological culture is an intangible, unifying force that links individuals to the society and to other individuals in the society, both past and present. How people view their culture is very complex, though it is important to note that most societies resist changes to their cultural assumptions, ironically unaware that change is only constant method of survival.

Despite their intelligence, societies are rarely conscious of the motivation behind their cultural paradigms; rather they see their culture as the natural way things are done. This lack of awareness coupled with reverence for tradition makes culture creation all the more complex. For example, consider an island community. Keeping pigs and feeding them vegetable surplus that would otherwise go bad is a selective advantage to the community. They store their perishable surplus into pigs, which can be slaughtered and eaten upon need. Over time pigs supplant their original purpose as surplus storage and become a measure of status (the more pigs, the wealthier the family, the higher their social standing). Given enough time and surplus, the community as a whole may gear their food production to raise more pigs (consequently attaining more perceived status within the community), while producing proportionally less food for the people of their community. If this switch in food production takes place, pigs become competitors for food resources rather than the consumer of surplus food. Although keeping pigs has now become a selective disadvantage, this island community may continue keeping pigs and using them as a measure of status because of an attachment to cultural mores.

Communities, their environment, and their cultural adaptations are a delicate balance to maintain. When traits are taken individually, they may seem to have no selective advantage but are beneficial in combination with other cultural adaptations. The balance is harder to maintain as cultures interact with new concepts, religions,





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knowledge, technology, magic, and trade goods. When cultures collide, individuals of the community must decide how these things fit within their cultural paradigms, creating many different approaches from a similar cultural basis. Only the survivors pass their culture to the next generation, which may account for the visceral reverence societies ascribe to their beliefs, practices, and crafts.

Though communities and their cultures develop uniquely, all societies address certain key stresses with similar social adaptations. While we separate culture in categories and discuss social functions of cultural practices, remember that societies rarely contrive their cultural mores to have those affects. Also remember that societies, crafts, ideologies, and institutions evolve concurrently, constantly creating, altering, and shaping one another.

Alignment

The natural world is true neutral, each member playing its role in a larger balance. When creatures develop intelligence, they have the ability to shape or determine their alignment separate of the natural world. Certain alignments have selective advantages within certain sets of conditions. For example, lawful people may have a selective advantage in environments with scarce but reliable resources. The best survivors in this environment rely on order, hierarchical leadership, and rigid accounting of resources. On the other hand, chaotic societies may have a selective advantage in environments with scare and erratic resources. Their flexibility and less-rigid social structure promote the survival of the species in this situation.

Most hunter-gatherer societies are chaotic in nature, with small, tightly-bound groups, low population densities, and little to no external hierarchical structure outside of their group. With the rise of agriculture, societies tend to show more lawful traits by forming larger communities, intercommunity organizations, and codified social structures. Pastoralists often fall somewhere in the middle, depending on their level of nomadic behavior. In general, the smaller the piece of land a society relies upon for survival, the more lawful they tend to be.

Similar trends exist in moral alignments as well. Good societies have a selective advantage in environments where reciprocity is the best method of ensuring individual survival. It is important to note that violence, competition, and selfish motivation take place in good societies, but on a whole they are not the favored method of conflict resolution and social interaction. Evil societies have a selective advantage where competition for resources is intense, and eliminating the competition best ensures individual survival. It should be noted that societies often act like their opposed alignment under unique stress. Good societies may engage in genocide while evil ones may support their neighbors against oppressors, but both societies, over time, vastly favor actions consistent with their alignment.

A few observations on these trends—neutral societies are generalists, while deviating from neutrality makes societies more specialized. Neutral and good societies are more likely to form complex civilizations while evil societies rarely form complex civilizations unless they are also lawful in nature. And lastly, there are gradations in these terms, and the degree of selective advantage derived from them varies from situation to situation.

Language

Communication between members of a community plays a vital part in culture formation, the most obvious being verbal communication. Intelligent races create language by assigning arbitrary sounds to objects and manipulating those sounds to express new, complex ideas. Language always reflects the needs of its speakers. For example, societies of the artic have more ways to express “snow” and “ice,” all bearing the subtle differences that materially affect their lives. One term may apply to

Words of Power

Every society has particular, unique methods of channeling magic, most requiring verbal components. Though these words of power are unique to each caster, they are highly influenced by cultural factors. Allusions, idioms, and cultural bias determine the path through which spellcasters evoke their powers. While druidic casters prefer to channel nature itself, clerics typically address more abstract forces, like the god of war or the power of good. Bards rely upon stories, myths, and cultural history, while sorcerers are more introspective with their focus. Wizards prefer to use older, archaic languages, in the hopes of tapping a primeval power. Other generalizations fall along racial lines and regional locations. Dwarves are more likely to call upon the strength of the mountain than elves, while a spring-fed lake in the desert evokes more magical attention than your average body of water.

Typically a smaller group splinters from a larger community. Initially they speak the same language, but given enough time and isolation from each other, they develop different languages. Spoken language easily mutates with use. Certain words and phrases are used more often, while others die from lack of use. Groups use different idioms to express similar ideas, but idioms only bear their meaning within their cultural context. Words get clipped, mispronounced, and adapted into different meanings, while certain sounds shift, making languages entirely different from their original roots. In more advanced societies, different classes often use different words, so communication within the same community is not always uniform.

Language also mutates through conquest. Conquerors may force subject people to adopt their language, weakening their subject's cultural ties.

"first snow," while another refers to "the snow that foreshadows a winter storm." They may have one word for "ice that is safe to cross with a sledge team," while another term applies to thin ice. People who live a leisurely-paced lifestyle may express everything in the present tense and use key words that mean "in the distant past," "in the recent past," or "sometime in the future." A society active in trade may borrow many words from other languages and assimilate them into their own tongue.

Without going into fricatives, dentals, aspirated consonants, and diphthongs, we can safely assert that languages sound different. Languages using endings to indicate number, tense, and gender usually rhyme because the same endings appear over and over. People living near the sea often speak with a singsong cadence, mimicking the sound of moving water. Some only use monosyllabic words and employ tonal subtleties to impart meaning. Other languages take preexisting words and squish them together to create new words, making long, lumbering sentences.

Language is extremely important to a society. The power of words permeates all cultures, hinting at words of power, bless, and curse. Many societies have myths concerning the origin of their language. Some propose the gods gave them their language (which you can do, but my gnome does not recommend it—better that they do it themselves). Others speak of a progenitor language of divine origin that is lost to mortal ears, and of course, theirs is the closest derivative language. Though this may be true for certain races, the main creators of different languages are physical isolation and colloquial adaptation.

Oral Traditions

Having a written language is not a prerequisite for cultural sophistication. Some societies reinforce and preserve their culture through strong oral traditions. Storytelling is an art form that passes the society's mores through retelling myths and history to the next generation. Societies with written languages also use oral traditions to reinforce their cultural mores because writing is often inaccessible to the majority of people in a community.



Tree Rat

Languages that do not have a syllabic alphabet but a logographic system express ideas in unique ways. For example, let's say @ is the symbol for "tree." To express "grove," I would write @@. To express "forest," I would write @@@. To express "squirrel," I would write @# (# meaning rat), making the exact translation of squirrel, "tree rat."

Subject people may retain their language but learn the conqueror's language for trade, communication, and administration. Subject people may retain their language but absorb much of their conqueror's language. A fusion language may emerge with traces of both languages.

Writing

Writing assigns arbitrary symbols to the arbitrary sounds that constitute language. The most basic form of writing is pictorial representation of an object. For example, early pictographic writers who want to express the sun draw a circle with rays shooting out from the circle. Over time, that symbol comes to represent not only the sun but also the idea of light. As written languages age, their symbols simplify because the need for exact distinction decreases with familiarity. With the example of the sun pictorial, why use six rays when three will get the point across? As writing develops, pictorial representations become more abstract, until there is no visible connection to the picture and the object it describes.

Some written languages further mutate into syllabic representations, where a symbol indicates a certain type of sound. Given our previous example with sun, over time people no longer put rays, and now simply write a circle. Say the word for sun is pronounced "bi-ma." When someone wants to write a different word whose first sound is "bi," they write a circle. This process proceeds with symbols continuing to change and simplify over time. While some written languages progress in this manner, others may begin as syllabic languages and continue their refinement from there.

The tools originally used in writing often determine the shape of symbols and letters. Clay tablets promote straight lines with indentions and writing tools without uniform shape. For example, an isosceles triangle easily produces four different symbols (point up, point down, point left, point right), while a circle can only express one. Writing on large leaves (like banana leaves) produce curved scripts because straight lines cut the leaves. Writing on hard surfaces, like stone, promotes straight lines because curves are difficult in that medium. Many societies do not create their own written language, but borrow an alphabet from another society, adopt the symbols of similar sounds, and modify the symbols over time. Such things occur between societies that trade and in conquered societies.

It is important to note that written language may vary greatly from spoken language. In general, the greater number of speakers and/or the greater geographical separation of its speakers produce a larger gap between written and spoken language. Writing often lags behind spoken language because its rules of usage are not as flexible, and literacy slowly works through the echelons of society. Writing is primarily for leaders, the wealthy, and their accountants/managers. Literacy spreads through the populace starting with people of higher social standing. As it becomes more mundane, elite groups within society quickly adopt the social responsibility of writing, striving to keep language pure and dictating rules of usage to that end. This can, of course, make writing inaccessible to many of its speakers. Other times it unifies a large geographical area with a common written language while its inhabitants speak different languages.

Religion

Religion is a cultural adaptation for intelligent races to resolve their intellect with their wisdom. It is one of the great truisms of the multiverse that truth cannot be spoken, only heard; such is the guiding principal behind religion. On an abstract level, religion gives individuals a route to everything greater than a single individual:



their society, the sky, death, the universe, and gods. Religion provides an explanation as well as a solution to life's problems through taboos, rituals, and atonements. On a concrete level, religions codify the society's beliefs, which are adaptations themselves, and regulate the behavior of individuals so a community can function with less friction (a task of growing importance as population density increases).

Most races initially worship natural phenomena or a specific part of nature. This may be a nearby mountain, a river whose fish and water feed the community, or an animal that the community hunts. As the society develops, its religious ideas may shift or expand. Religious ideas become more abstract to accommodate the expanded knowledge of the society. Suddenly the mountain is not god, but is home to an anthropomorphized god. The surrounding forest is also worshipped along with the river. The specific animal is no longer the sole focus of worship, but the animal spirit in everything. Some religious focuses become removed from nature, usually in conjunction with urbanization and separation from the natural world. Instead of worshipping the god that brings rain, people worship the goddess of the hearth, or the force of law. Though the evolution of religion follows this general pattern, the evolution of any specific society's religion does not have to follow this sequence.

When creating a society's religious beliefs, look at their landscape, subsistence pattern, and societal development/history. Majestic parts of their environment may prove worthy of worship. Rivers and lakes provide daily requirements, while mountains and large rock formations induce awe by their size or orientation. Natural caves provide shelter and are sometimes filled with spectacular mineral formations. Volcanoes and earthquakes demand attention by their violence, if for no other reason. People of the arctic that experience days of continuous darkness and days of continuous daylight probably have religious explanations and rituals ascribed to such phenomena.

Next consider what they eat. A society usually worships that which it perceives as providing it food. Hunter-gatherers usually have an animistic religion, showing respect for the animal that gives its life to feed the community. This respect for the animal is a selective advantage for hunter-gatherers because it counters instinctual over-predation and encourages them to use all parts of the animal, for wasting any part would be ungracious. Such cultural adaptations encourage long-term survivability for hunter-gatherers. Pastoralists often revere their herds, ascribing social spiritual





relationships between the animal and the community. For example, cattle-herding societies may see the cow as a mother figure, providing milk, clothing, and fuel; or horse people may value speed and strength, two attributes encapsulated in their herd. Pastoralists also ascribe to abstract ideas, like fertility (increasing and strengthen the herd) and health (warding off disease). Agriculturalist religions focus on natural cycles and things affecting the harvest. Ample, timely rainfall; fertile fields; seasonal cycles occurring at predicable intervals; warding off disease and pests; and the intimate connection between the fruits of the field and the community they feed is common in agricultural religion.

Finally, consider the history and development of the society. Religious ideals are old companions to intelligent races, but the institution of religion does not begin until communities settle into permanent sites, food production frees people to become full-time religious functionaries, and centralized powers use deep-rooted beliefs to justify mobilization of resources. Literacy also affects developing religions. Societies that preserve thoughts, doctrine, and history in writing create a potentially larger pool of cultural knowledge, while information passed orally has an effective limit, both in size and complexity. Older developed societies typically have more complex beliefs and practices because they have more remnants from religious customs of the past that must be reconciled with the religion of the day.

Another factor is cultural temperament. Martial societies value physical strength, victory in battle, and often look at things through the eyes of a warrior. One martial society may value mercy as a result of such violent history, while others may justify their pursuits through religion with a "holy fighter" paradigm. Societies active in trade often revere that which guides and protects them during their travels. Stars hold a special place in trading societies, as well as hospitality since traders often find themselves visitors in another man's land. Seafaring societies revere water, wind, stars, and the forces that protect the boat and its sailors. Societies in pursuit of philosophy value knowledge, "scientific" understanding, and quantifying. Religious societies are more likely to retain religious integration in every aspect of life, due to its ideological stronghold in culture. Such societies practice a million small rites as they perform daily tasks.

Myths

Myths are the cultural stories passed from generation to generation. They often explain how things originated; why things are the way they are; and who is to blame for death, unhappiness, starvation, and other unpleasant aspects of life. Myths preserve the past, record the present, and foreshadow the future through a cultural lens. Usually spoken or sung, myths socially unify the community through shared knowledge, for everyone knows the stories, players, and endings. But the recounting of myth, a ritual of remembrance itself, grounds each individual further into his community.

Myths are shaped by religious focus, environment, and general outlook. For example, communities living in extreme, hostile environments are intimately familiar with harsh realities and carry this into their myths. They often have imperfect creation myths, where the creator/god makes a mistake

Creation Myths

Every society is curious about how they came into existence. Almost all myths start with a divine creator.

Sometimes the creator makes the world and then populates it with people. Other times people come first, and god must then create a world for them. Most creation stories involve a creator giving, breathing, or sweating life into soil and making man. Some myths give a special distinction to the first man and/or woman. Either they are created in a way unique from the others, or they have greater powers. Regardless of the actual events of their existence, maintaining uncertainty (though uncomfortable for intelligent beings) is a main fuel for their ingenuity.

Who Came First?

Worlds with multiple intelligent races usually have two or more racial societies claiming to be the first race. This treasured position of first creation seems too much temptation for otherwise rational intelligent beings, leading them into philosophical and religious battles, and sometimes into actual combat. While some societies are prone to fight for an implied superiority that dates back to beginning of time, others are content in embracing a single divinity as their creator and regarding themselves her treasured creation.

during creation. Death usually plays a prominent role in stories, with a comic tension between mortals and their creators. Gnomes usually have trickster heroes in their myths, often getting the better of larger, more powerful beings. People living in wet areas tell creation stories where the world is initially all water, and a divinity forms land by touching mud dredged up from the bottom of the water.

Some myths claim to recount history, events that actually happened, were recorded, and are now retold. Historical myths are commonly used in describing battles, survival through physical trials, and the lives of prominent social figures. This may be a play by play of a war between the virtuous free people fighting off vile oppressors. Perhaps it speaks of a catastrophic event that their people survived, like a volcanic eruption, flood, or extended drought. Many tales speak of virtuous people and their foils, giving the community concrete examples of expected and unacceptable behavior. One important point about historical myths: the further back the event, the more poetic license taken by storytellers and bards.

Other myths convey morals that further flesh out a society's character. What do these people think is important, what do they think is a virtue, and what cultural quirks arise when things get complex? These tales either blatantly point out acceptable or unacceptable behavior, or they recount tricky situations without answers, letting the community shape its current feeling on the matter.

One trait that permeates all myths is balance. Things usually exist in opposition pairs like day and night, or a pair of brothers, one wise, and the other foolish. When numbers are used, they repeat themselves throughout the story. When numbers are applied to opposition pairs, the numbers are usually equal; if there are seven dwarves, there are seven elves. Imbalances in number usually imply that something is wrong or justifiably unequal.

Taboo

Taboos are foods, behaviors, and objects that individuals abstain from in accordance to their cultural mores. Taboos usually originate from religious beliefs, though they sometimes outlive their root religion. Though the majority of taboos do not provide a scientifically measurable benefit, taboos are an integral part in the development and continuation of culture. Their primary goal as an adaptation is social organization. Some taboos have additional benefits that promote personal and societal welfare. For example, not eating pigs (and therefore not keeping pigs) reduces pig and human disease interchange (common cause of many diseases in human societies). When a society designates which hand you eat from and which hand you wipe your ass with, people avoid contact with the dirty hand, which reduces incidence of disease. Other societies never taste their food during the cooking process or before serving, another taboo that prevents spreading diseases.

Food taboos define and categorize food by how, when, and when not to eat certain things. While some cultures simply forbid people from eating types of food, many societies create sets of conditions for consumption. Consider a society in which pregnant women are supposed to eat a certain type of root, thought to help the baby grow to term. Perhaps this root is scarce in nature and difficult to cultivate, so women who are not pregnant are forbidden to eat this root. In fact, part of the prestige associated



with pregnancy is the ability to eat this root, and one way to announce a pregnancy is to serve the root to the expectant mother at a dinner party. Food taboos may also cross into the medicinal realm. Certain foods cure symptoms, while other foods bring on physical problems and should be avoided. Taboos may also dictate how something is prepared before it can be eaten, again sometimes physically beneficial, other times completely arbitrary but uniformly so.

Taboos surrounding objects are more abstract, often embodying a culture's anxieties. For example, a society with low population growth and a high incidence of miscarriages may have object taboos associated with pregnancy. Perhaps the conception bed cannot be moved until the baby is born, or pregnant women cannot use knives or other sharp objects for the first three months of the pregnancy. Seafaring societies have many taboos concerning their boats and ships. Women cannot touch the prow of the boat, lest the navigator lose his way. Do not leave on a fishing venture without tying a banana leaf to the stern with red string. While many of these taboos seem unhelpful at best and arbitrary superstition at worst, some have their benefit. For example, consider the taboos passed down from generation to generation on cultivating crops, firing pottery, metallurgy, and shipbuilding.

Behavioral taboos regulate how people interact within a society, as well as outside their society. The most common behavioral taboos deal with sex. Many cultures do not approve of incest, homosexuality,

or bestiality. Others prohibit having sex while a woman is breastfeeding, before a hunt, or religious ceremony. Other taboos ease social tension by defining and prohibiting behavior that causes friction. Sharing sexual partners after reproduction is one such taboo. In conjunction with rituals, taboos regulate how people are supposed to behave in certain situations and demand accordance by reinforcing belief in supernatural forces that punish disobedient individuals. This may not be as blatant as a lightning bolt striking your house, but perhaps your cow is ill because you did not give your brother's first son an appropriate gift at his 30th day party.

Avatars

Revealing your will to your subjects is not always easy. Often the barrier between divine and mortal comes down to a question of familiarity. When you wish to interact with mortal races, choose a place that evokes reverence. Holy groves speak strongly to elves, but hardly to orcs. Rolling hills of green pasture draw halflings' hearts, while the stalwart strength of stone strikes true to dwarves. For gnomes, try a damp cave with shining mineral formations and sparkling gems. After choosing an appropriate place, next manifest in a guise they understand and revere. Carry sacred cultural objects, appear as their herd animal, or wear the robe of resplendent feathers from a mythic bird—whatever it takes to get the message across. You are divine, you have something to say, they better listen, and follow instructions. But remember the universal truism: the truth cannot be spoken, only heard.

Ritual

Rituals are observances and events that societies perform, engaging in formal periods of concentrated, enjoyable association. Though some have their roots in religious ideology, they are all social events with social benefits. Like taboos, rituals give the community social structure through different approaches. Rituals that redistribute wealth, resolve disputes, and promote hospitality ease tension between members of the same community. Rituals that celebrate life cycles and natural cycles alleviate individual anxiety over the greater forces that affect their lives. Though rituals are social affairs, they can also be personal journeys. The beneficial affects of ritual rarely lie in the particular components of the ritual, but their significance to the individual performing the ritual. Rituals create culturally defined paths of proper thinking and feeling before completing a task, from simple tasks like walking out the front door to complex ones like building a boat.



Redistribution of Wealth

People living in close proximity to each other irritate one another; that is another great truism of the multiverse. Culture provides adaptations that ease this tension by establishing a standard operating procedure and socially accepted methods of expressing and expelling social tension. The oldest and most common method of easing tension is through redistribution of wealth. Some cultures throw feasts where wealthy families give portions of food to poor families. Other cultures create sharing partners between unrelated families to increase the overall survivability of the community. Some fishing communities create mini-stock exchanges, where families own shares in different fishing boats, ensuring a larger number of people have food, even when some boats do not catch any fish. Agricultural societies may allow young and old members of the community to glean the fields after harvest, supplementing their family's food supply. Some societies use this principle to garner friendly relations with neighboring communities. In general, sharing the wealth makes more people happy. Societies that engage in ritual redistribution of wealth also uphold the virtue of the rich, either through virtuous praise or as a symbol of status (i.e. I am rich enough to slaughter and give away ten pigs).

Other methods of ritual redistribution of wealth are not as friendly. Some herding cultures promote internecine raiding to redistribute wealth from the older, weaker generation to the younger generation. These raids provide the prerequisite wealth for young men to marry and create the next generation. Other cultures raid neighboring communities, common in places of scarce resources and plentiful but poor land. When communities become too large, social friction may lead to a fracture. Sometimes this fracture is voluntary, and individuals leave the larger group to found their own community. Other times this fracture is forced upon the dissidents. Fracturing is one way that intelligent species move around their planet.

Dispute Resolution

Cultures mitigate friction by establishing methods of dispute resolution enforced through social pressure. Dispute resolution sometimes overlaps with redistribution of wealth when losses are equated to a fiscal equivalent. For example, if someone's son eloped with another man's daughter without paying the proper bride price, there may be a fiscal compensation for the loss of a daughter (used to create food sharing partners and alliances). In egalitarian societies, the whole community may preside over the dispute. As societies become more centralized, key figures like chiefs, leaders, or religious figures preside. Some cultures use rituals to resolve disputes, leaving it up to god and his interpreter. A few methods include reading oracles, augury, consulting spirits, interpreting tossed dice, undergoing ordeals, and trial by combat, which test the veracity of the disputants' claims.

Hospitality

Hospitality is a cultural adaptation that codifies the treatment, reception, or disposition toward visitors. This codification creates social order among the community and subsequently defines proper behavior based on status within the community. The codes of hospitality vary greatly from society to society. What is a proper greeting when welcoming another man's daughter into your home? Do guests bring gifts when they visit someone else's home? Do hosts offer food and drinks to visitors? Are visitors supposed to accept? Who sits where during community feasts? How long do daughters-in-law tolerate their visiting mothers-in-law after the birth of a child? Some cultures expand this codification into extensive sets of social rules. In societies that measure familial importance by age, families record the exact time of birth to properly categorize their members by status. Some communities use wealth as a determinate of treatment, though each society measures wealth in different ways. Diversified cultures





may also determine reception through occupation, e.g. merchants are better received than grocers, who are better received than laundresses, who are better received than septic cleaners.

Hospitality also affects how cultures treat outsiders. Some cultures pay outsiders the highest honor, offering them the choicest food, drink, accommodation, and entertainment. Others are outright hostile, seeing foreign intrusion as a threat regardless of context. Most cultures are somewhere in between, mixing a healthy measure of pleasantry and caution. Some communities treat outsiders as a source of entertainment amused at their physical differences and ignorance of how things work. People who receive more visitations from outsiders have more developed customs concerning their treatment and reception.

Birth

Cultures often celebrate or communally observe the stages of life, maintaining personal and social order. Celebrations of birth are very common because of their symbolic ties to renewal, fertility, and creation. Some societies tie a religious significance to births. For instance, some societies think newborns are closer to the divine and prevent them from crawling on the ground, lest they resemble animals. Other societies may see birth as a vulnerable time when the divide between the spiritual world and the physical world is thinner. Such cultures may seclude the child and mother for a set amount of time to ensure the survival of both. There may be certain foods, stories, dances, songs, and instruments associated with a new birth in the community. One society may serve colored eggs at birthing celebrations, another may recite the creation story of the first birth, while another only allows flutes and female singers to ensure the baby's first sounds are sweet. Many communities name the baby, dedicate the baby to a patron deity, or perform an act of ritual decoration, like piercing, body painting, makeup, or circumcision. Societies usually have different rituals depending on the sex of the baby, reinforcing from birth the cultural mores of each gender. Not all births are celebrated events; some cultures practice infanticide. Other cultures may even cannibalistically cull their population, saving only the heartiest of young.

Coming of Age

Coming of age celebrates an adolescent's passing from childhood into adulthood. The rituals usually differ according to gender, with different criteria and celebratory customs for males and females. Female coming of age usually has to do with fertility, marriage, or the birth of a first child. Some societies physically signal adult females through clothing, color, adornment, body painting, or scarification. While some cultures treat female coming of age with less fanfare, others throw festivals announcing their daughter's eligibility in marriage. Males usually have to undergo a task before coming into their adulthood. This could be a physical journey, where they leave as children but return men. For example, boys of herding societies may enter manhood when they leave the women and travel with the herds. Some cultures may determine an age of adulthood and symbolically reenact the journey in a ceremony.

Marriage

Marriage is a social recognition and celebration of union. Cultures ascribe different rights with marriage, but most make a formal arrangement between two people who are mating partners and share the responsibilities of a common household, though they may live in separate buildings and responsibilities may be gender-based. Though marriage is between two people, it is often a communal affair. Approval from both families is not an unusual prerequisite to marriage, as well as an exchange of gifts. Sometimes males must have a certain level of fiscal resources before marriage; other times the bride's family may have to pay a dowry, sometimes considered an inheritance to their lost daughter and her new family. In some societies, marriage must occur within the community, while other societies insist people marry outside their community to create more mutual ties. Others call for long periods of engagement to ensure the female is not pregnant with another man's baby. Most cultures codify who may marry whom according to social status.

Regardless the particulars, marriage usually constitutes its own status for both men and women. A married woman may garner more respect and higher social standing through her marital status and her husband's status. Women usually physically signal their marital status through distinct clothing, jewelry, or adornment. Married men

also garner prestige through their wives and their children, which manifests differently in each society. Some cultures may translate higher number of children with robust virility. Other cultures may view children and wives from a fiscal vantage, where both are expensive and having many attests to a great wealth.

Each culture celebrates marriage differently but there are a few common threads. Many observances have a pre-ceremonial seclusion based upon gender. The female members of the community prepare the bride, while the male members prepare the groom. Appropriate teasing, singing, dancing, and advice solidify cultural bonds and ease personal anxiety over a life change. Certain clothing is only worn during one's marriage day, as well as body ornamentation.

Processions unite the secluded couple, making marriage ceremonies a communal



event—sometimes sober, other times with boisterous song, chanting, or music. Many marriage celebrations have a religious component, where the couple stands before a divine witness who substantiates their bond. Then the community breaks into feasting and drinking, paid for by the families of the newlywed couple. Like all rites, marriage customs are passed from generation to generation and create a cultural continuity that expands a personal stage in the life cycle into a communal celebration.

Death

Death rituals are present in almost every culture. All things die, and intelligent creatures spend their lives in the knowledge of their inevitable end. Cultural adaptations relieve this stress by providing answers about the unknown and solutions through ritual. Many cultures explain death as a function in a greater cycle of life. Some cultures believe the dead live on in a spiritual realm, while others believe the dead rejoin a greater overarching spirit. Cultures may believe the body dies, releasing the spirit to enter into a newborn body, while others think the spirits of the dead walk among the living, capable of interfering for good or ill. Cultural adaptations provide a method of categorizing death while easing personal anxiety through rituals. Death rituals are a social context to express and release personal fear, grief, and anger.

All cultures have rules to follow when someone from their community dies. Death rituals are meticulously followed because of a visceral fear of discontent spirits returning to wreck havoc. Sometimes these rituals are somber, other times they are celebrations, lest the spirit think everyone will miss them too much and decide to linger. First, certain people prepare the body for the afterlife, either members of the family or religious figures. Bathing, dressing, anointing with prized oils, covering with special colored cloth, and applying makeup or a likeness of the dead are common methods of preparing the body. Some societies embalm or preserve the body, while others extract vital organs. Some preparations require proper ambience, like incense, music, praying, or repeated weeping. Some prepare gifts to the dead to use in the afterlife, such as food, tools, crafts, and luxury goods. Processions are common in death rituals, guiding the spirit to its final destination. In one culture, when someone dies away from their community, family members carry the body back home so the spirit finds its way to rest. Along the road, they talk to the spirit, engaging it so it doesn't rest prematurely.

The actual ceremony usually takes place in geographic locations with religious significance. Societies may build a cairn around the body high on the mountain, releasing the spirit closer to the heavens. Cultures that burn their dead on pyres may release the ashes over a sacred lake. Communities may build tombs facing east, so the dead experience rebirth every morning. Other cultures may bury their dead in a sacred clearing circled by ancient, knowing trees. Seafaring people may set their dead adrift, embarking on their last journey to sea, while some feed their dead to the vultures, returning them into the cycle of life. Ceremonies usually include music, singing, chanting, and praying. A religious figure typically leads the community in ritual, cathartic in its familiar cadence. The ceremony makes death a social affair, and some societies demand certain behaviors. Some communities demand wives to throw themselves on their husband's pyres to show their devotion. Sometimes women must weep continuously for many days to show proper respect. Others designate a period of mourning where certain behaviors are prohibited (e.g. remarriage, drinking, eating certain foods, wearing certain clothes), and a symbol of remembrance is worn (e.g. a ban around the arm, a colored ribbon worn in the hair).

While most cultures view death as the end of physical life, there are those who seek to diminish death's grasp. Some sought to restore life to lost loves, only to animate the dead. Others sought to bypass death, only to live in death for eternity. Still others found pleasure in death itself and brought death down wherever they went. Intelligent beings give life to some of the greatest atrocities in their quest for resurrection magic, for giving life is not the same as restoring life.



Natural Cycles

Natural cycles hold a cherished place among intelligent races. People live their lives by these cycles; gathering fruits, nuts, and seeds according to their unique ripening, hunting animals abundant during various times of the year according to migration and birthing patterns, moving herds for water and grazing, planting crops at appropriate times, and predicting the tides all depend on mindful observance of nature's rhythm. Ritual observance of natural phenomenon often depends on a culture's subsistence pattern, environment, and unique history. For instance, farming societies celebrate solstice because changes of season cue specific agricultural activity. Herding communities celebrate spring as mating season and summer a time of birthing, relying on the fecundity of their animals for survival. Fishing and seafaring communities celebrate cycles of the moon because of their significance in tidal patterns. Communities living in areas with dry springs and heavy summer rains ritually celebrate the life-giving wet season. Other events like solar and lunar eclipses, continuous days of night (artic areas), volcanic activity, comets, annual flooding, and atmospheric disturbances (e.g. aurora borealis) may also garner regular observances.

Rituals for natural cycles encompass many elements. Some involve supplication or thanks, in which giving gifts to divine representatives is common, whether they are objects, locations, or religious intermediaries. Some use reenactments that symbolize natural events with songs, dances, and performances. Lastly, all rituals involving natural cycles are mindful of the passing of time; whether through lunar cycles, solstices, or the movement of the stars, cyclical nature is the ultimate timepiece. So pervasive and visceral are these cycles that religions often use these days for religious celebrations. Sometimes the ritual takes on a religious character as the society develops institutionalized religion; other times religions choose these days to bolster the celebration of their religious ideals and rites.

Cultural Rituals

Cultural rituals are social events particular to cultural history. They usually involve historic events or figures upheld in community, mixed with a good dose of storytelling, heroism, and political maneuvering. These acts of remembrance take on a ritualistic tone when cultures ascribe specific social behaviors with their celebration. For instance, a culture celebrates the heroic death of a sea captain (killed in defense of the city) by baking dense bread and throwing it out to sea on the day of his death so the fishes will not disturb his body for food.

Religious ritual is another type of culturally specific event. Every community has its own method of religious observances, though some ascribe membership to a larger religious community. Some religious rituals are similar to historic cultural rituals in practice. They celebrate the historical figures and events of the founders/agents of the religion. Religious and secular powers may politicize religious rituals to influence the populace at large. For example, an impending war may cause community leaders to focus on the righteous might of historic religious figure rather than his serenity and mercy developed later in life.

Other religious rituals focus on ideological directives posed by religious leaders. More commonly called rites, these socially ascribed practices vary in purpose. Some are reminders of religious tenants and reinforce desired behavior through emotional ties to religion. Many rites are associated with cleansing or purifying. Socially, this allows religion to define what emotions/actions are good and reinforce their beliefs through ritual purification for wrongdoing. Many rites overlap or engulf rituals concerning life cycles. Birth, coming of age, marriage, and death are all potential ideological property of religions.





When Societies Interact

There are only two ways people interact, peacefully or hostilely. Instinct and history lies with hostility, from small tribal scuffles to large military affairs. The social trend is for smaller groups to merge into larger groups. This occurs either through actual conquest or from smaller groups banning together against hostile, external forces. In warfare, outcomes vary depending on overall population density. When population density is relatively low, defeated societies move farther away from their victorious neighbors. When population density is moderate, there are insufficient vacant areas for the defeated people to flee, and victors do not have social or economic complexity to require slaves. The victors most likely kill the men, possibly take the women for marriage, and take over the territory of the defeated community. With high population density, victorious societies, by now chiefdoms or even states, have use for slaves in intensive food producing schemes. Victors typically leave the defeated society in place, but deny them political autonomy and demand regular tribute in food, goods, or money. In short, the victors engulf defeated societies. One aggressive action may trigger a chain of migrations as the “losing” tribe from one conflict displaces a weaker tribe, who then displace another tribe weaker than themselves.

Peaceful interaction among societies typically involves trade. Many specialized societies often trade with neighboring societies, specialized in a different, compatible way. For example, high-altitude herders trade their animals’ dung for lowland farmers’ food, or coastal fishing communities trade meat for inland farmers’ crops. Trade is also a way for people to acquire new things in a world where resources and specialized crafts are localized. For example, some societies produce different color dyes or have different types of minerals and stones. Each society has unique patterns, symbols, and designs typical to their culture. Clothing made from animals living in highly specialized environments (silk or cashmere) is only produced by societies occupying those regions. Overlapping trade partnerships carry goods, ideas, and technologies across vast continents and through different ecologies.

Mapping Your World (Part III)

Step Seven: The Origin of the Major Intelligent Races

The origins of major intelligent races largely depend on what type of creation you want, but it is always easiest to work with the system than against it. Given that assumption, I also know that you probably want to create your own races by hand, so we'll find a way to do both. What nature likes to do is create environments that apply pressures on creatures to survive. By adapting to these pressures and passing adaptations to further generations, creatures undergo physical and behavioral changes. In this way, a small creature becomes a large one given millions of years. In this process, some creatures develop intelligence. Intelligence is a shortcut adaptation compared to all others. Intelligence allows a creature to recognize the systems around them as systems and not just stimuli. It also allows them to better manipulate their environment to suit their needs rather than waiting for genetic and evolutionary adaptations. It's a very powerful adaptation, and it's what we gods are interested in. Eventually these intelligent creatures learn to survive in almost every environment through their cleverness. They may even find a way to traverse over large bodies of water, given enough time, experiment, and luck. It seems impossible that an island in the middle of a huge ocean would be populated, but it happens. As long as intelligent creatures can survive, they'll continue to expand their territory.

The movement and expansion of intelligent creatures are our focus for mapping. But before you start mapping where your races originate and where they migrate, you need to decide what your major races are going to be. How many intelligent species are you going to have, knowing that wars are inevitable, and some species may have selective advantages over others? In other words, you should be prepared to lose a few of your races due to any number of factors, luck being an important one. Of course, you can always create them again, but let's keep our magic expenditures to a minimum and prevent unnecessary expenses.

Once you've chosen your major races, place them next to major rivers or within 50 miles of the shore. Also, don't put them at high altitudes; it's easier closer to sea level. Now move them around. Move them up and down the river they occupy, and then watch them jump to other environments that abut their home river. Given hundreds of thousands of years, they'll be everywhere, and may have already killed off each other. That's their nature. We don't have the right to change that as godlings. But instead of creating "finished" races, you should create ancestor races rather than creating each race from scratch. Ancestor races are the "proto-races" from which other races spring forth. This can explain how some races are capable of interbreeding (but not always) and eases the first steps of a complicated history.

Step Seven: Example

I've decided on the major intelligent races in my world: elves, dwarves, humans, gnomes, halflings, orcs, goblins, hobgoblins, and kobolds. That's a lot of intelligence and perhaps not all of them will make it through.

Placing these races is a bit of a challenge, so I began with ancestor races. The river on continent E is the birthplace of one of my ancestor races: the ancestor race of humans, elves, and orcs. Some of these can interbreed when this whole process is done, so I need to address the different environmental pressures that caused the ancestor race





to diverge. But that is later. The rivers along the mountain range on C are the birthplace of the ancestor race for the dwarves, gnomes, and halflings. All the "little people" on one continent pleases me. The ancestor race of the goblins and hobgoblins appear on the desert river on continent B. This leaves only the kobolds, which come from the rivers on continent A. Right now I've four centers of origination. This is a good number, and there's only one large landmass (continent D) without major intelligent species.

Step Eight: The Movement of the Major Intelligent Species

Our next mapping step is to move our ancestor races out of their swaddling-lands and into the territories they'll claim as birth lands. There are a few things that we should consider in this step. The most important is rivers. People prefer to move and populate areas all along rivers rather than deviate away from rivers. It's easy to understand; water is life. Next, it's easier for creatures to stay in their own familiar climate zone than to move out of it, making east/west movement easier than north/south movement. Sources of food (plants and animals) and appropriate shelter are more similar east/west than north/south because climate is more variable north/south. Altitude also plays a role here. People settle lowlands before highlands, all things considered. These lands of easy expansion are birthlands of the ancestral race.

Move your ancestor groups around according to these primary factors. They quickly claim these parts of the world, then they move into less familiar terrain. This second migration is harder to define and occurs for many different reasons, but remember the above two factors. If one of your ancestor races moves east/west and encounters a river, they'll expand to fill that river as well. In a way, it's sort of like the children's game leapfrog. It's in this manner that the great north/south rivers play an important role, because although the climate changes faster, at least one thing is staying the same. North/south movement is much faster with a river than without. The last type of expansion is the most likely to fail, but the most spectacular: sea expansion. When a population becomes crowded and there's nowhere to easily expand, internal war and more daring expansion attempts occur. Wind direction and ocean currents are the two most important aspects of expansion. If a race can move with water and air currents, their chances of finding shore greatly increase.

Once your ancestor races go through two, possibly three expansions, there is a good chance they have encountered another race or a significant physical barrier, like a desert or mountain chain. These things both limit expansion for different reasons. Meeting another race inevitably leads to violent conflict while meeting a great physical barrier inevitably stalls expansions. How you wish to handle the conflict is up to you, but assuming that your races are both competitively viable through similar or different survival strategies, you'll probably have a rough line of racial control that moves back and forth throughout time. Of course, one race can get a permanent upper hand and drive another into less fruitful lands, but even then, the "dominant" race doesn't "own" these lands like it does their birthlands. It takes a long time for dominant races to engulf subject races at this point. More than likely, periodic warfare continues indefinitely as the subject race in the hills and forests attack the dominant race that owns the valleys and plains.

Two final notes: don't forget the coastline and consider spacial restraints. Even well developed worlds have the majority of their populations (up to 70% in worlds with billions, yes billions, of people) within 50 miles of the coast. Coasts are great sources of food, and the call of the water pleases nearly every intelligent humanoid ever created with its cyclic to's and frow's. Spatial restraint may start speciation off earlier in an ancestral race, and it often leads to quicker overseas expansion.

Step Eight: Example

This example is best understood by looking at the included map. Each age shows the progressive expansion of each ancestor race as time goes by. All of this expansion takes place before agriculture and the development of cities; the extended nomadic family is the unit of these intelligent animals. Also remember these ages are really ages; they're thousands of years, even hundreds of thousands.

My ancestor races take off along rivers and along the east/west axis first. The goblin/hobgoblin group claims all of continent of B, the elf/human/orc ancestor race claims all of E, the future dwarves/halflings/gnomes claim continent C, and the kobolds claim continent A. There are a few points of interest in the migrations according to each age. The first age is the riverine and east-west expansion period. During this time, each race takes the easiest route of expansion. During the second age, the goblin/hobgoblin moves along the great north-south river through the desert to expand along the more hospitable coast while the elf/human/orc group and the kobolds expand along the coast of their respective continents. Both groups avoid their deserts. The second age is also the end of easy expansion for the dwarven/gnome/halfling group, meaning their densities increase and speciation may occur. During this period, I had them start to show differences in build, height, and behavior according to their preferred terrain, but they're still one race right now. The kobolds have also run up against the mountain group caused by continents A and D colliding. This barrier stops them for a long time until they learn to adapt.

The third age is an exciting one because the dwarves/gnomes/halflings make it across the ocean to continent D through the beneficial ocean and air currents. They find a land that, although containing a lot of different plant and animal life, is very similar to the land they left behind. They survive and continue to reproduce, claiming the northern portion of continent D. During this period they make first contact with another intelligent species, the kobolds. The kobolds have finally gotten through (and around) the mountain chain on the isthmus between continents A and D. They found the environment harsh, but survivable, with the land north of the mountains better than the land south. In the north, they meet the dwarf/gnome/halfling ancestral race. Chaos, madness, and death ensue. Don't try to stop it, you can't. I don't find it very fair either. For the human/elf/orc and hobgoblin/goblin group, the third age is more like the previous one. They both expand where it's easiest and most familiar. They do manage to conquer their local desert environment, but density is so low it's almost non-existent.

The fourth age claims all the land on the world for some intelligent ancestor races. Although some islands were conquered earlier, all islands are now populated by intelligent proto-races. The isthmus between continents A and E rage with conflict as the human/elf/orc group has finally met the hobgoblin/goblin group. Continent D has become the most hotly contested real estate in pre-history because not only have the gnome/dwarf/halfling ancestor race and the kobolds taken part of it, but the intrepid orc/human/elf group has grabbed a hold on the southern tip.

Step Nine: Divergence and Divergent Expansion

Once expansion slows down for any reason and large portions of a race have spent significant amounts of time in differing environments, species divergence occurs. Given the magical nature of our worlds, this divergence can be extensive and very sudden. This step creates the races we're all familiar with: elves, humans, dwarves and all the other various humanoids. Depending on what races you want on your world, you'll need to look at the environments where your ancestral races settled and select the one which is most associated with what you desire. For example, you'll probably want your dwarves to come from rocky mountainous areas. After settling divergence, you can start sub-speciation if you wish. The various different sub-races are reflections





of additional specialization to a particular environment. My gnome cautions me to not get “out of hand” on this, but that’s his preference. You’ll have your own, I’m sure. Once you locate where the new races develop, they expand. During this expansion, the ancestral races are still around, and every newly developed race is still capable of breeding with them as well as each other, but this won’t last for much longer. The young races quickly out compete their forefathers, and their territory expands while the ancestral races’ territory diminishes. This is very similar to the manner in which the ancestral race originally spread throughout the world, but faster and more deadly. Given enough time, the ancestral races that spawned children races are no more, and only a few of their descendent races are even capable of interbreeding.

But what of the ancestral races that don’t evolve into new races? These are not as rare as one would think, and they don’t stop evolving. There’s no way to stop that, not for we godlings. The ancestral races that survive are just that, survivors. They are scrappy and more than likely hold their own against all comers. These are the races that may even outlast the other “more developed” races. What they often do however, is undergo sub-race development pattern directly, spewing out sub-type after sub-type, all well developed to exploit their particular environment and all capable of interbreeding with all the other sub-types. This is often greatly to their advantage.

Step Nine: Example

Now that everyone’s got nowhere to go, they settle down to constant conflict with themselves and their neighbors and specialize. Over the ages, they learn a particular environment well and find particular ways to exploit it. Eventually, magic takes a hold of them, and nature pressures them into different races. Again, this takes a very long time, and now they may start toying with a new thing called agriculture. The races have finally developed enough to be individually discernable. As shown on the map, each race rose from a particular area within their ancestral race’s territory. Every ancestor race sprouts younglings except for kobolds—they’re like the roaches of intelligent species. Eventually I’ll have them expand to all the continents (just like every other race), and they’ll just be too numerous and crafty to destroy. Good must always have something to be wary of. Anyway, back to the map.

Kobolds watch their territory diminish on continent D as gnomes and humans expand over two ages. On continent E, humans expand inward, eventually claiming most of the desert and the coastline, separating the majority of orcs from elves. Elves and orcs lose the ability to intermingle through this geographic separation over a few more ages, but elves and humans continue to breed through their wars and alliances. Goblins hold their own, until they meet hobgoblins, who conquer them completely and use them as a servant race. Dwarves and halflings expand, destroying their progenitor race, but then they hold their own as dwarves start to delve deep for the first time, relieving the pressure on their society.

It’s important to remember that every race has diversity within their group. For example, the dwarves have the underground/mountainous branch as well as the more arctic types living on the northern shoreline of B. The kobolds cover so many different terrains that every possible subsistence/cultural pattern can be found on continents A and D. The hobgoblins may develop the first kingdoms along their Nilesque river because the soil is naturally fertile, renewable, and predictable, conditions that may make agriculture quickly surpass hunting/gathering as the main subsistence pattern. Also, the stability of the river prevents the universal abuse of land done through short-term survival needs that tends to destroy civilizations and thus promote continual occupation of the same land for hundreds of generations. Other races will have similar differences develop within their race. Don’t assume that all elves come from forest people and all halflings are gardeners.

That's it. The races now have their terrain, their histories, and their reasons for how they are as well as where they are. Eventually dwarves find themselves carving kingdoms out of kobolds' mountains and in elvish mountains. The latter location leads to tragedy after elves betray dwarves to goblins, and an enmity exists for eons. But every race eventually makes its way around the world, given enough time. Through this whole process, I've spent some of my magic energy to push their developments the way I want them to go (can't leave everything to chance), but only minimal amounts are needed through this process to get a reasonable amount of what you wish. Budgeting our magic is the most important aspect of our divine existence, and your world is a reflection of judiciousness.

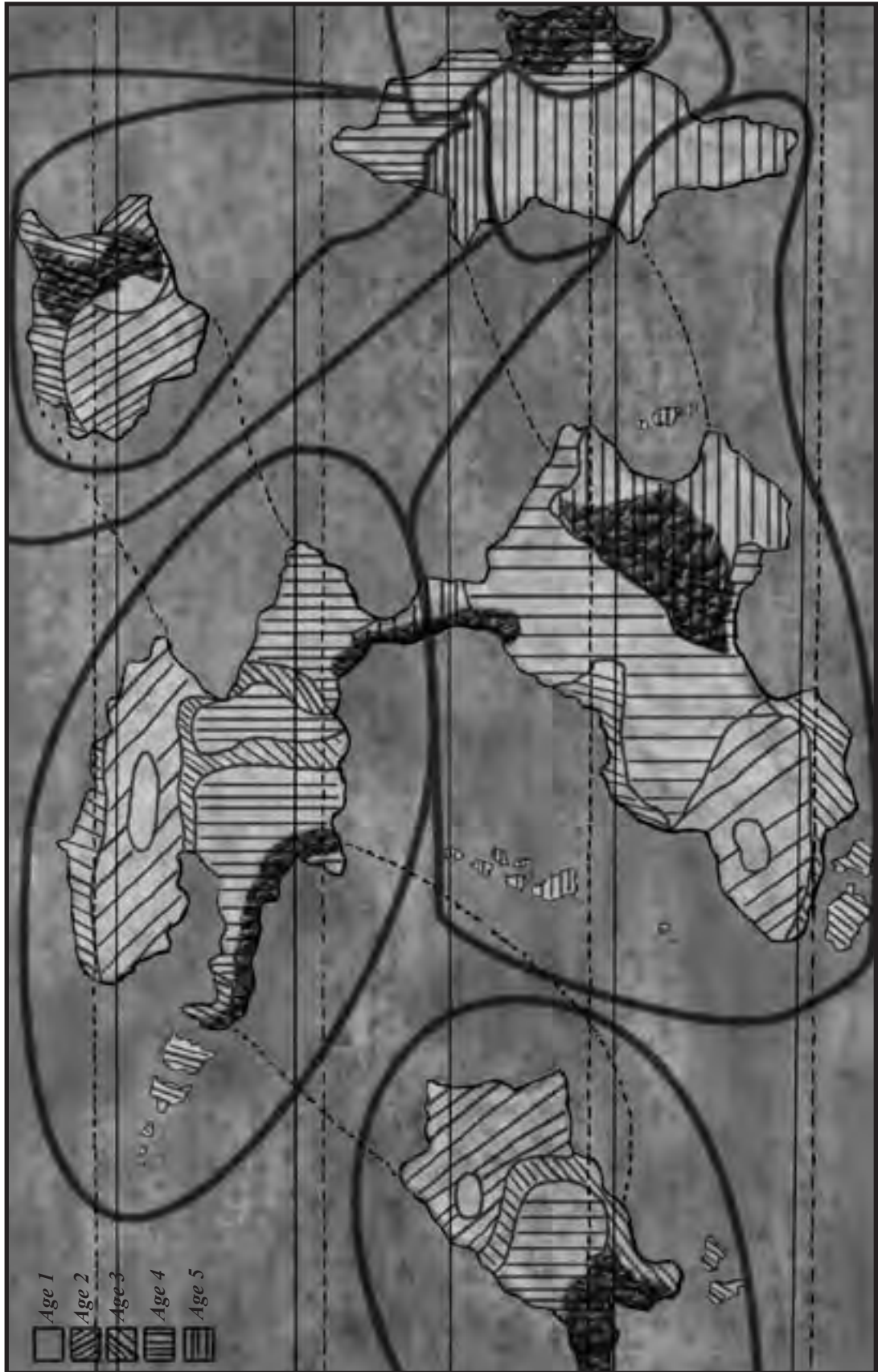
But that's another story. My work here is done.

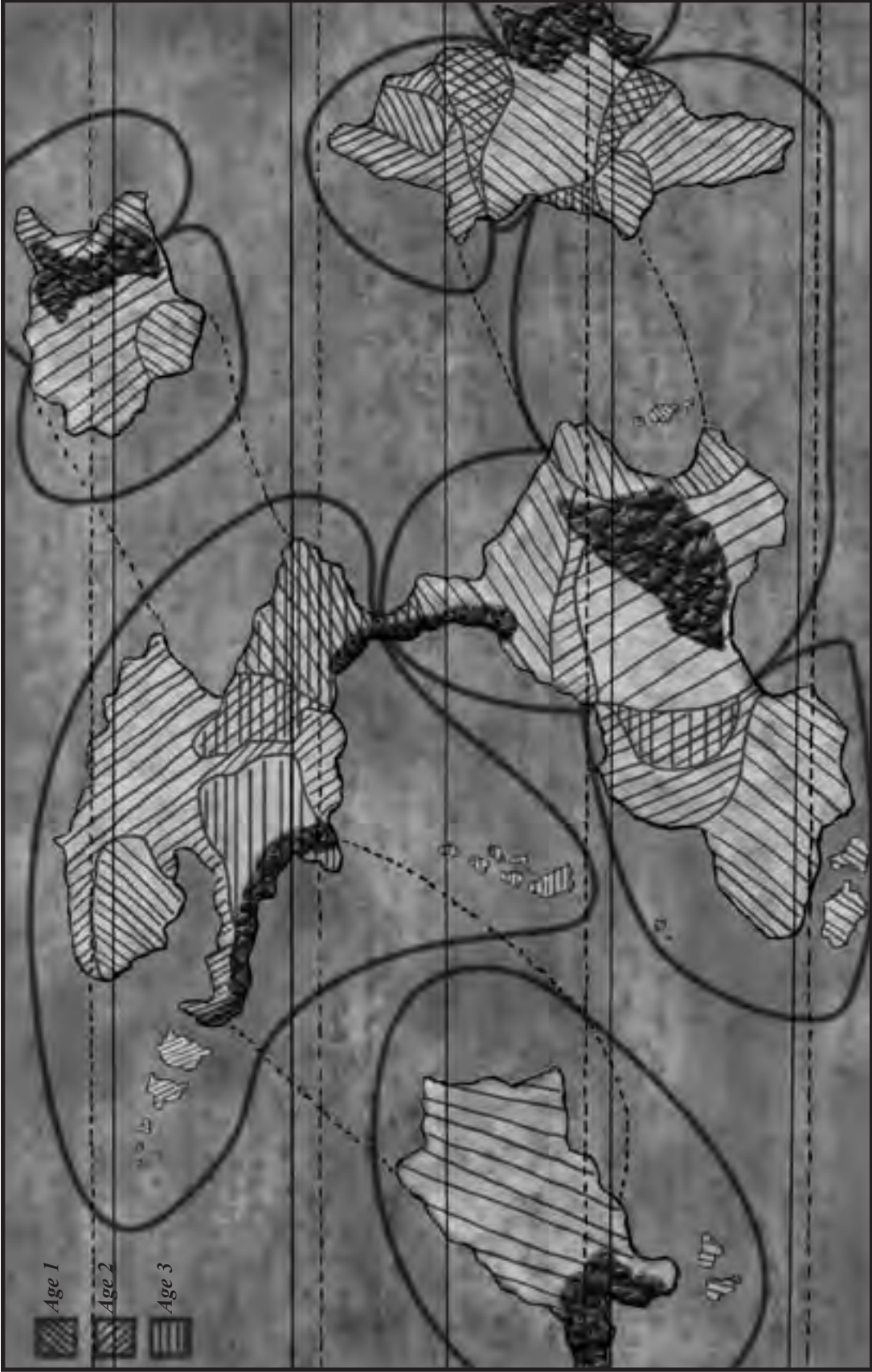


Ah... Things were simpler then...



Mapping your World ~ Steps 7 & 8





Mapping your World ~ Step 9

Final Interlude

"Sign here." Noj motioned with the end of the quill. Kierian penned "Kierian the Bold, God of War, Bringer of Justice." The gnome blew on the fresh ink before closing the book.

"So that's it. Nothing left to do but wait," Kierian said, shrugging his shoulders hesitantly.

"You can always practice your abilities, or visit the library," Noj suggested as he packed up his supplies. "Merrick said they got the loveliest scenery books from Veradil the other day."

Kierian watched his assistant, so efficient in his movements. Likely he never expended any extraneous energy. The godling shifted his attention to his world, swaddled in wisps of clouds. The spring thaw trickled down, filling diminished riverbeds and lakes, while rain fell over the highlands. "Do you think I'll pass?" Kierian asked in a far away voice.

"That will be for the Council to decide." Noj gathered the last of his things and carefully wrapped the manuscript in cloth.

The summer sun warmed the arctic, calling all manner of large mammals and flightless birds to mating season. Violent storm clouds poured heavy summer rains over the tropics, while wind-whipped, water-torn rock scuffed off island volcanoes. Kierian chanced a question. "What do you think of my process?"

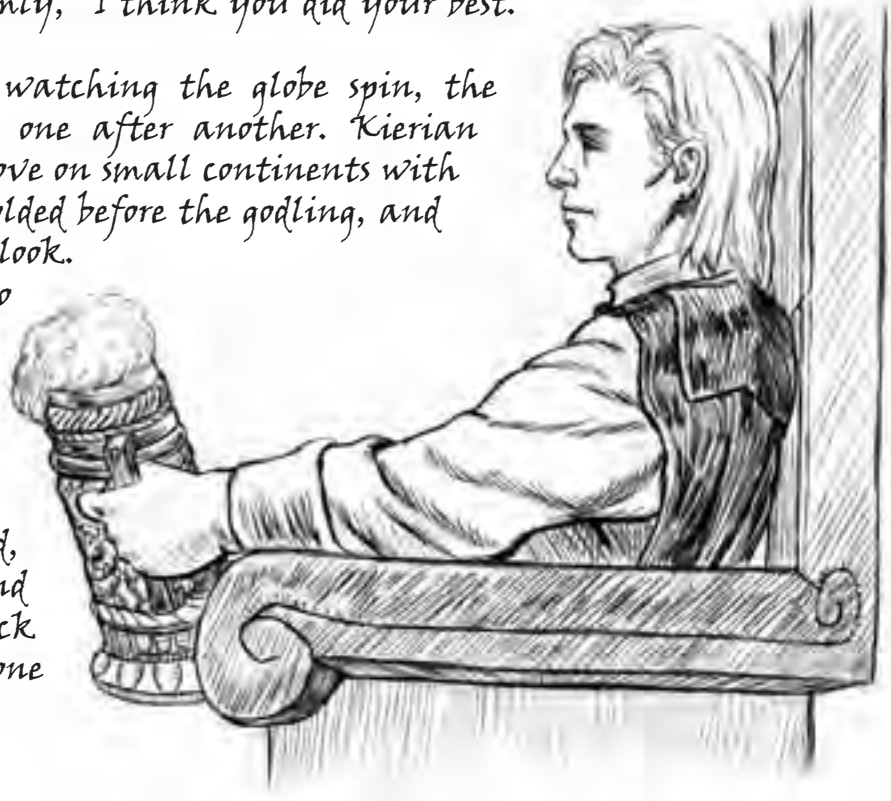
Noj answered warmly, "I think you did your best." With that he left.

It was hypnotic, watching the globe spin, the seasons marching along one after another. Kierian watched little figures move on small continents with such purpose. It all unfolded before the godling, and he couldn't help but look.

He thought back to something his friend once told him long ago. Nothing is real except for those living within the creation itself.

Kierian the Bold, prospective God of War and Bringer of Justice, sat back in a self-fashioned throne and had a beer.

"Bollocks."



Appendix

Formations

Aragonite: A calcium carbonate crystal that decorates caves. These long, needle-like crystals form when the water reaches high magnesium to calcium ratio, which intensifies in evaporation. It is not uncommon to find calcite formations tipped with aragonite spikes and tinsels.

Arêtes: A ridge crest between two cirques in close proximity. As the glaciers move downhill, they can cut into the rock between the two cirques. Arêtes are the narrow, serrated spine of rock between two cirques.

Artesian Wells: Wells formed by faults in impermeable top layer of rock. This water comes from far away sources, carried though a layer of permeable (porous) rock in between two layers of impermeable rock. When fault line occurs, the weight of the accumulated water forces water up through the fault line, reaching the surface. They can occur in any environment, but are particularly important in dry climates. For example, the Nefta Oasis has 152 springs, all from artesian wells.

Atolls: A coral reef encircling a landless lagoon. Atolls are ring-shaped and consist of strings of closely spaced coral inlets separated by a narrow channel of water. They are the final stage of volcanic islands, after the volcano dies and the land is eroded below the surface. Sometimes rock fragments and soils collect on coral reefs in atolls, forming a circle of new islands.

Barchans: Crescent-shaped sand dunes. Barchans are formed by strong steady winds blowing from a single direction in dry deserts. As the wind blows, sand grains fall over the crest and double back on themselves, forming a steep leeward face. Over time this process makes steep crests lined up in a triangular formation. Example: Great Western Erg.

Barrier Islands: Long narrow sandbars built up in shallow offshore waters. They run parallel to the coast and are anywhere from a few hundred yards to several miles in the sea. They are the result of debris collected where large waves begin to break in shallow waters of continental shelves. Barrier islands prevent new seawater from penetrating the waters between the shores, creating a lagoon between the mainland and the barrier island. Over time, mudflats form from deposited silt, turning the lagoon into marshy waters. Example: Padre Island.

Barrier Reefs: Coral reefs around a volcanic island that forms a lagoon around the island. Dense coral reefs growing in close proximity form a wall around the island based on the underwater slopes of the volcano. This wall prevents fresh sea water from entering the lagoon, save the brief openings in the coral reef. Example: Bora Bora, Great Barrier Reef.

Batholiths: Enormous rocks with a surface area of 40+ square miles. These single rocks form when magma collects under the surface and pushes against the surface without erupting through it. When the magma cools, a single rock is formed that will later be exposed through erosion. Batholiths can be single features, though they often form the core of major mountain ranges. Example: Sierra Nevada (California).

Brine lakes: Bodies of water with high concentration of salts and little to no oxygen. Brine lakes were bodies of water that once emptied into the ocean, but have since been separated from their traditional drainage. Usually the lake is raised through uplifting and can no longer drain into the ocean.





Sometimes the ocean or sea has disappeared in long past geologic time. As the lake is fed by traditional sources without any drainage, salt concentration rises when water deposits salt as it evaporates. Another cause of brine lakes is alkaline springs, where lakes are fed from springs that travel through rocks with high salt content. The spring water leeches the salt from the rock and feeds the lake salt water. Salt deposits gather at the shore and also form columns that break the surface of the water. Some communities harvest this salt for trade. Some brine lakes are so saturated with salt that it is near impossible to sink or dive into the water. Virtually no life, shy of few bacterium and microorganisms, can live in brine lakes. Brine lakes can also be found in larger bodies of salt water, such as the Mediterranean Sea and the Gulf of Mexico. They remain a separate distinct system within the ocean, maintaining a higher salinity than the salt water surrounding them. Example: Dallol Salt Plain, Dead Sea, Mono Lake.



Calderas: Large steep-sided basins created when volcanoes erupt, collapse, or do both. Though rare, they are spectacular formations because the crater left behind is many times larger than the original volcanic vent(s). When magma levels drop, the weight of the volcano is no longer supported by upflowing magma. If this pressure is not mitigated, the volcano collapses, forming a caldera. Sometimes the calderas become lakes, other times they become fertile ground with mineral-rich volcanic soil. Examples: Crater Lake, Ngorongoro Crater.

Canopy: The treetop section of the rainforest. Over 50% of the biomass in the rain forest is found in the canopy. The trees in the canopy do not touch or overlap but fit together like puzzle pieces. They shut out sunlight for the forest below and lock in the moisture and heat below the canopy. They also act as an effective wind block, keeping the air in forest floor humid, hot, and still.



Canyons: Created by uplift, erosion, and rivers. Canyons usually form in sandstone and limestone. River erosion is the primary creator of sandstone canyons, although mass wasting and uplift play a significant role. Limestone canyons commonly form when caves or cave systems (honeycombed throughout the rock by underground water flow) collapse. Examples: Bryce Canyon, Cheddar Gorge, Grand Canyon, Gorge Du Verdon.

Cave bacons: A short drapery with iron bands striping horizontally. When seen through a light source, it looks impeccably like bacon due to the reddish hue of the iron and the wave of the drapery.

Cave balloons: Small gas-filled pouches made of hydromagnesite found on cave walls. Solutions under pressure (forced out, not free flowing) seep through cracks and pores. They encounter moonmilk as they come out, and the gas fills the moonmilk like a rubber balloon.

Cave blisters: Rounded mineral deposits on cave surfaces that are filled with sediment or another mineral. They form when solutions are forced out of small cracks and holes by capillary pressure.

Cave bottlebrushes: Cave formations hanging from the ceiling with a narrow top and a thick bulbous bottom. They form when stalactites are immersed in a cave pool for a long time. If the pool is supersaturated with calcite, underwater mineral formations will cover the stalactites, forming a thick bulb or cap, giving the bottlebrushes their name.

Cave pearls: Concentric mineral deposits that look like pearls, though they are sometimes elliptical or square. They are found in shallow cave pools where water drips and calcite forms around sand, rocks, or other objects. Continuous dripping can create pearls the size of golf balls.



Cave rafts: Sheet-like deposits that form on cave pools. Sometimes they stick to the walls, forming shelfstones, or they fall to the bottom of the pool. When many rafts stack together, they form raft cone stalagmites.

Caves: Areas carved out of rock by water. They are found anywhere there are massive limestone deposits at or near the surface. Water percolates through the bedrock, eroding underground streams, tunnels, and caverns as it goes. Rock floors, steep passages, the presence of canyons, and tight meandering curves are telling signs that a fast flowing river cut the cavern. Slow rivers leave behind level passages, silt and sand covered floors, tube-like passages, and sweeping curves in elongated sections of meandering paths. There are often decorative deposits of calcite covering the floor and ceiling. Some features associated with caves are columns, scallops, stalactites, stalagmites, and other speleothems. Example: Amarnath Cave, Blue Grotto, Cheddar Gorge, Fingal's Cave, Frasassi Caves, Jaguar Cave, Mammoth Cave, Red Flute Cave, Wakulla River.

Cenotes: Vertical shafts filled with water. They are sinkholes where the ground collapsed, making an entrance into the cave below. They are similar to moulins in ice caves.

Chemoclines: Where freshwater aquifers intersect pockets of sulfur-saturated, oxygen-depleted water. Strange things live here.

Cirques: The place where alpine mountain glaciers once originated. Repeated episodes of glaciation erode the mountain, forming a broad, gently sloping floor and steep side and head walls. When the glacier travels down hill, fragments of the cirque are carried away with the flowing ice. They vary in size, from a few acres to a few square miles. When cirques become lakes, they are called tarns. Example: Cirque de Gavarnie.

Cols: The area where two cirques have cut into the rock and through the arête that once divided them. The cut in the arête varies in size.

Coral Reefs: Usually grow on continental shelves or around volcanic islands. Coral requires shallow water (no deeper than 180 feet) whose year-round temperature is no less than 68°F (20°C). They have calcium carbonate skeletons covered in soft, colorful tissues of all shapes. Coral eat single-celled algae to build reefs through secreting more calcium carbonate. Extensive coral reefs act as surf breakers, leaving the immediate water around the coast relatively calm. Around volcanic islands, reef can become so dense they become barrier reefs. Coral reefs are home to countless species of fish, sponges, and echinoderms. Examples: Bora Bora, Great Barrier Reef.

Cupola: A dome-like rising in the ceiling of lava tubes. They usually form when windows to upper passages are sealed off with cooled lava.

Deltas: Land formed at the mouth of the river where more sediment is dropped faster than the sea can remove it. Sometimes deltas form within the river's own bed, forcing it to cut new channels. Deltas come in all sizes, but the largest have been forming for millions of years. For example, the Indus River has formed most of Pakistan, and Bangladesh is the largest delta in the world with soil deposited by the Ganges and Brahmaputra River. Examples: Okavango, Mississippi Delta, Nile Delta.

Desert fogs: Deserts on the coast may receive precipitation from the atmosphere. A dense night fog rolls 50 miles inland every 10 days in the Namib Desert. The fog condenses into thick dew, which provides more water in the region than rainfall.

Eskers: Long ridges of stratified drift. As a glacier recedes, streams tunnel through the glacier carrying gravel and debris. When these streams are stopped up, the debris collects, making sinuous ridges called eskers. Eskers are usually a few dozen feet high, a few dozen feet wide, and up to a hundred miles long.





Ergs: Large areas of sand. In sharp contrast to the desert plains layered with gravel, rocky plateaus, and salt flats, ergs have a surface layer of sand that is highly subject to wind. Winds that blow in one direction form barchans, or crescent-shaped dunes. Winds that constantly change direction create all manner of dunes, from huge mounds to broad troughs edged by teeming sides of sand. Due to the lack of obstacles, wind speeds in ergs are as fast as 30 mph and often create sandstorms. Ergs can even migrate up to 30 meters a year if driven by a strong and steady wind heading in a single direction.

Estuaries: When a river flows slowly into the sea, tides sometimes push salty water upstream. Estuaries are coastlines with water flowing in both directions and are home to a mixture of both salt and fresh water tolerant creatures. Like any wetland, they are rich in life, and they vary in size from a small stream to huge areas of salt-flooded marsh.

Fault lines: The lines where two tectonic plates meet. When plates slide against each other (either in opposite directions or in the same direction traveling at different speeds), they cause earthquakes. Example: San Andreas Fault

Fibrous Speleothems: Cave crystals that are fibrous or filament-like in nature. They form when saturated water is squeezed out of pores and deposit minerals when they hit air. The four types are hair, cotton, rope, and snow, determined by the size of the pore of which it was squeezed through.

Fjords: A long, narrow, steep-walled, u-shaped coastal inlet. As glaciers expand and recede with global temperature changes, they gouge out rock and earth from the river valley, creating fjords. Examples: Milford Sound, Sognefjord

Flowstones: Mineral deposits that cover a surface or wall in a sheet. They often have draperies at the bottom and also form canopies. Bell canopies are classical mushroom-shaped features formed when flowstones form around rocks or clay and the material is later washed away. Baldacchino canopies form when the water level drops in the cave, exposing the belly of flowstone and its bare underside.

Gas Hydrates: Undersea deposits of solid methane. Methane is usually a gas, but becomes solid under enormous pressures found on the deep sea floor. When a piece of methane breaks off, it returns to its gaseous state, expanding into a giant bubble. The methane bubble erupts upon reaching the surface, which scientists speculate as a possible cause of spontaneous sinking of ships. If ships are far away from the bubble or exactly on top of the bubble, they are fine. But if ships are in the area between the stagnation point and the edge of the mound, it's sinking fast because enough water does not support part of the ship. Scientists are not sure how large these bubbles can get. Example: Witches Hole

Geothermic areas: Areas where heat from the core of the earth vents to the earth's surface. Sometimes these vents are violent and unpredictable, others are constant sources of energy, capable of being harnessed by animals and humans alike. Though the cause of geothermic locations is unknown, some speculate that the earth's crust is thinner or more susceptible to fracture in geothermic areas. Sulfur is often released in large quantities in geothermic areas, making the area smell like rotten eggs. Geothermic areas that manifest on land produce volcanoes, geysers, hot springs, and mud pots. Geothermic areas in the oceans may create pockets of life in otherwise barren places. Example: Strokkur, Whakarewarewa.

Geysers: Pools of steaming water that periodically erupt and send boiling water in the air. Though most active geysers shoot water less than 150 feet into the air, some have been recorded to shoot water as high as 1,500 feet into the sky. They are often found near hot springs, where underground water has come into contact with heated rocks or magma. Examples: Old Faithful, Pohutu, Stori Geysir.



Giant's kettles: Deep cylindrical potholes carved out of rock by erosion. When water takes a sudden change of direction, it causes a circular current, better known as a whirlpool. The water and any debris caught in the whirlpool carve out large bowl-like depressions up to 20 feet deep. Example: Bourkes Luck Potholes.

Glaciers: Massive, long-lasting accumulation of compacted snow and ice that forms on land. Alpine glaciers (glaciers in mountainous regions) slowly flow downhill, carving out flat-bottomed, U-shaped valleys in their wake. On level land, glaciers flow outward under their own weight. The upper and middle parts of glaciers move faster than the sides and base, which are slowed by friction. If a glacier pushes as far as the sea, its snout breaks up into icebergs and float away. Glaciers also shape the landscape with various formations: arête, cirque, col, esker, fjord, hanging valleys, horn, kame, kettle, moraine, nunatak, paternoster lakes. Examples: Athabaska valley glacier, McBride Glacier.

Green Icebergs: When a glacier moves over seawater, forming an ice shelf, bits of seawater rich in organic material freeze onto the underside of the shelf. When an iceberg calves off of the ice shelf, it usually flips, exposing part of the green underside. Most ice shelves contain no green ice.

Hanging valleys: Small glacial valleys high above the floor of the main valley. They form when a large glacier carves out the main valley and smaller glaciers feed into the larger glacier. From the surface of the ice field, the two seem level, but the smaller glacier does not carve out the rock as much due to less weight and debris. After the ice melts, the small tributary glacier valleys drop off into the main valley. Hanging valleys are prone to form waterfalls.

Halocline: A fog-like layer separating freshwater and saltwater. Bizarre creatures inhabit these waters.

Horns: Steep-sided pyramidal rock pinnacles formed by expansive erosion on the headwall where three or more cirques meet. Examples: Matterhorn

Hot Springs: Areas where underground water has come into contact with heated rocks or magma and subsequently forced up to the surface. The mineral-rich water comes to the surface heated, sometimes boiling. As the spring water cools (or in some cases evaporates), mineral deposits form. Hot springs on slopes often form terraces of travertine or silica, depending on the mineral content of the water. Examples: Lake Bogoria, Mono Lake, Whakarewarewa.

Ice caves: Caves inside of glaciers shaped by melt water. Like water cutting through limestone, melt water cuts through the ice, continually flowing toward the sea. Some ice caves form through steam from volcanic vents. Ice caves tend to be long horizontal caves with banded sides and ceilings of packed snow. If rivers encounter faults, they cut down creating deep pits call moulins. Eventually the water finds its way out and forms the headwaters of a fjord. Because the walls are glacial ice, the cave reflects and transmits color from mineral deposits and light sources, giving an eerie glow to the freezing air. Cave-ins are more common in ice caves than traditional caves because of their snow ceiling. Ice caves are also highly mutable due to seasonal cycles of melting and refreezing. Example: Kyrksgöll.

Ice shelves: A massive portion of an ice sheet that projects out over the ocean. They can extend up to hundreds of miles into the sea. Ice shelves can get 2,400 feet thick inland and rise hundreds of feet above the sea. Ice shelves move anywhere from 5-10 feet a day, pushed from behind by glaciers, from above by snow, or from below by ice. Large pieces of the ice shelf fracture and break off, forming huge ice burgs, one reported larger than Belgium. Example: Ross Ice Shelf.



Kames: Mounds of sediment deposited as the glacier recedes. Melt waters push out gravel and larger debris from the glacier, which builds in fans or deltas against the edge of the ice. After the ice melts, the mound partially collapses and forms hills of stratified drift, called kames.

Kettles: Depressions in the earth made by large pieces of ice left behind from glacier movement. These depressions often fill with water, creating kettle lakes. The typical depth is 10 meters or less, while the diameter varies from tens of meters to a kilometer.

Lagoons: A body of quiet salt or brackish water. They usually form in areas between mainland and a barrier island or a barrier reef. In the case of barrier islands, lagoons become choked with sediment and/or silt deposits that become marshes, mudflats, or meadow. In the case of volcanic barrier reefs, the lagoon will eventually become atolls as volcanoes die and erode away. Examples: Bora Bora, Padre Island.

Lava balls: Lava balls form when pieces of a lava tube's ceiling break off and fall into moving lava. Moved along by a molten river, the lava ball grows in size, similar to a snowball rolling downhill. These lava balls are found stuck to the ceiling, pushed through windows or skylights and deposited on the side, or wedged in tight constrictive passages of the lava tube.

Lava falls: Waterfalls of lava found on the lower levels of lava tubes. These molten waterfalls behave like typical waterfalls. The turbulence of the falling lava cuts a deep basin below, forming lava lakes and sunken plunge pools in larger falls. Lava falls can cutback into the supporting rock through thermal erosion, melting away the rock. When the lava flow recedes, it leaves a high-ceiling chamber downstream which marks the lava flow at the height of the falls.

Lava roses: A drip formation found on the floor of lava caves. These little roses form when sheets of molten lava drip from the ceiling. The center depresses from continual layers of falling lava sheets, making the center of the roses, while the individually cooling sheets of lava form the petals. Lava roses also form when upwelling lava boils up through the partially solidified floor.

Lava Tube Caves: Caves that are carved by molten lava. They usually form on the sides of volcanoes or along gullies and trenches. The top of the lava hardens, insulating the bottom of the lava and allowing it to carve out caves by melting the rock, not by erosion. Lava tubes have carried fluid lavas 50 or more miles from their source. Many lava tubes are close to the surface (less than 20 feet and sometimes less than a foot). Consequently, the upper layers of a lava tube may have tree roots hanging from the ceiling like tinsel or beaded curtains. Depending on the type of lava, the walls and floors may be rough and bumpy with piece of pure aa lava (called clinker floors), or smooth and ropy pahoehoe lava. Lava tubes have their own collection of formations: cupola, lava ball, lava falls, lava roses, runners, shark tooth stalactites, splash stalactites, sunken plunge pools, tubular lava stalactites, upwelling lava, and windows. Examples: New Mexico's El Malpais.

Mangrove swamps: Coastal wetlands found in tropical and sub-tropical regions. They are often found in estuaries and protected tidal bays. Mangrove swamps are where salt and freshwater intermingle with the tide. The basis of mangrove swamps is the mangrove tree, whose aerial roots allow them to flourish in the shallow brackish waters. These trees hold the soil down and create an ecosystem for salt-loving plants, algae, bacteria, filter feeders, wading birds, fish, and crocodiles. Mangrove swamps also act as nurseries for big sea-faring fish like sharks and tarpons. They diminish shoreline erosion, reducing the negative effects of heavy surf and incoming storms.



Meteor Craters: Craters made when a meteor or meteorite hits the Earth. They are circular bowl-like depressions with a steep rim that often rises higher than the plain. Meteor craters are huge, the largest on Earth with a diameter of two miles and depth of 800 feet. Meteors do not have to be particularly large compared to the crater they leave behind. What they lack in size and weight they make up in velocity. The 70,000 ton meteorite that formed Meteor Crater in Arizona was traveling 29,960 mph, making a blast equivalent to 20,000 tons of TNT. The impact devastated an area with a radius of 100 miles from the point of impact. Geologically, meteor craters are distinct from volcanic-made craters in the presence of rare forms of silica created under the high temperatures and pressures of impact. Examples: Chubb Lake, Meteor Crater.



Moonmilk: A soft, white, claylike substance present on the walls of many caves. It is goeey and pasty (like plaster of Paris) when wet and chalky when dry. It is a carbonate, dripwater precipitate.

Moraine: Mounds or ridges of debris and till deposited by glaciers. They are usually much longer than they are wide, though they can be as wide as several miles. Glaciers push off debris in various directions and at various times, leaving different types of moraines. The debris left behind when the glacier is at its greatest advance is a terminal moraine. Ground moraines form when a glacier recedes at an even rate, depositing a thin layer over a broad region. Ground moraines often fill old channels and level the terrain, disturbing preexisting drainage patterns. This can result in great swampy areas. When a glacier pushes its debris to the side, it forms a lateral moraine. When glaciers meet, their lateral moraines moves along with the two glaciers, forming a medial moraine.



Mud flats: Areas where mud collects that appear as a solid sheet of mud. They are generally found in coastal locations, especially in estuaries. Though they appear solid, the ground underneath is soft mud. The illusive swamps can consume those who step in, sucking them in like quicksand. In deserts, they are created by seasonal collections of water, which is then absorbed in the dry soil, becoming a muddy swamp. The summer sun dries the surface of the mud, giving it the appearance of firm ground. Examples: Chott Djerid.



Mudpots: Areas of boiling mud, heated by geothermic sources. Mudpots are hot springs that do not have much water. The water in a mudpot is very acidic, and it dissolves nearby rock into small pieces of clay. This clay then mixes with the hot water to create mud. Hot steam rising from below causes the mud to bubble and pop as the steam is released into the air. Though most are small, mudpots can get as large as 70 feet across. Some people call them "porridge pots" when the mud is particularly thick. Examples: Gumper.

Nunataks: A hill or mountain completely surrounded by glacial ice.

Paternoster lakes: Series of shallow lakes often connected by streams, rapids, and waterfalls. They form when glaciers pluck out a sequence of small basins in a glacial valley and fill with water when the glacier recedes.

Petrified forests: Wood turned into stone. In order for this process to take place, dead trees are usually swept away by water and collected in areas that are covered with thick deposits of mud, sand, and ash from nearby volcanoes. Over time silica permeates the dead trees on a cellular level. The minerals either take on the shape of the cells, creating a copy of the tree or the silica replaces the wood cells, creating an inert replica of the tree. The trees are quartz or crystallized into semiprecious quartz, such as agate, jasper, onyx, carnelian, or amethyst. The petrified logs are covered by sediment that eventually becomes sandstone and shale, both relatively soft rocks. Erosion and upheaval exposes the petrified wood. Examples: Petrified Forest, Sigri.





Plugs: The solidified volcanic vent of a dead volcano. When a volcano dies, the remaining magma in its vent cools in the shape of the vent, forming a very hard rock. Erosion exposes these dramatic plugs that rise out of the surrounding landscape as wide as the volcanic vent. Though plugs are a single giant rock, some plugs appear as a cluster of basalt columns, shaped into hexagons as they slowly cool. These basalt plugs are still a single rock, only fluted by the cleavage of the rock. Example: Devils Tower, Le Puy de Dôme.

Oases: Areas in the desert that have natural supplies of fresh water. This water comes from far away sources, carried into the desert through a layer of permeable (porous) rock in between two layers of impermeable rock. Oases form where the top layer of the impermeable rock has eroded, exposing sand to the permeable rock. The water then seeps up through capillary movement, watering the soil. Oases can also form around artesian wells. Examples: Nefta Oasis.



Red tides: When the sea turns red from the abundance of dinoflagellates. These tiny red marine organisms thrive when super-abundant nutrients combine with continuous sunshine, coloring the water red or brown. Large blooms are dangerous for sea life, consuming most of the oxygen in the water and asphyxiating fish. Red tides also produce a virulent poison, dangerous to humans who eat mussels, clams, and other seafood.

Runners: Lava stalactites that form on the walls or on other stalactites. They look like dripping paint or veins that come out of the rocky landscape.

Sandstone arches: Naturally occurring arches made of sandstone resulting from erosion. They take on red, pink, lavender, and brown hues, depending on the time of day. Rivers in canyon formation carve out arches, as well as rain and wind erosion. The highest arch is 309 feet tall spanning a canyon 278 feet wide. At its peak, the arch is 42 feet deep and 33 feet across. The longest natural arch spans 291 feet, but its arch is only 6 feet thick, bone-thin compared to the erosive forces at work. Examples: Delicate Arch, Landscape Arch, Rainbow Bridge.



Sandstorms: A solid wall of swirling sand, often occurring in ergs. They can form quickly due to the fast and frenzied wind that blows unimpeded across the sand. Gravel and coarse sand swirl low, from the waist down. Thinner sand moves above the gravel, burrowing into every crack. Dust and the finest sand whirl high in the air and can travel great distances. This layer blocks out the sun, not only in the heart of the storm, but for many miles out.

Scallops: Indentations in cave walls that indicate the speed and direction of water flow. Small 1 inch scallops are indicative of fast flowing water, while large 10 inch scallops are formed from slow moving water. The steep side of the scallops is upstream.

Shark tooth stalactites: Broad stalactites that come to a point at the bottom. They form from accretion as excess lava pushes outward in the cooling process. As the still moving molten rock flows by, it deposits a thin layer of lava, which cools and builds upon the protrusions. It's similar to dipping candles, where layer after layer builds the stalactite.



Shelfstones: Ledges that stick out of the walls over cave pools or attach to other speleothems dipping into the cave pool. Calcite builds laterally and underneath the ledge, thickening the shelf over time. Shelfstones are particularly stunning when the water has drained from the cave pool and the shelfstones remain marking the water line.

Showerheads: A rare cave formation only found in tropical caves, showerheads are calcite formations that form on the ceiling under a seep site. They sprout out in a conical shape with a narrow top and a wide bottom. Sometimes they are more cylindrical in nature.

Sinkholes (dolines): Rounded depressions formed by dissolution of carbonate rocks (e.g. limestone). Sinkholes are where surface runoff enters ground water circulation, eroding rock as it filters into the ground. The soil settles leaving the sinkhole. They range in size from shallow depressions few yards in diameter to hundreds of feet deep and a few miles in diameter. They are good indicators of cave formations in the rock below and can be caused by the collapse of a cave ceiling (collapse dolines). When sinkholes become plugged with soil and no longer filter water in the ground, they become ponds. Sometimes sinkhole ponds can become unplugged, and a body of water as large as several acres can disappear overnight. When sinkholes link and intersect, they form valleys called uvala. They can also leave tall pinnacles and pillars behind called tower karsts.



Snottites: Acid-secreting microbial strands that hang like viscous stalactites. The tips of some snottities are 0.0pH. They are found in caves that have a high content of hydrogen sulfide, methane, and carbon monoxide because the microbes are chemosynthetic, using the natural chemical reactions of such gases to build cells. In some caves, the walls and ceilings are completely covered with a white gypsum paste carrying acid-secreting bacteria. Long (1-2 inch) snottities are called "stringers," while two-inch disks are called "phlegm balls." Example: Cueva de Villa Luz.



Soda lakes: See Brine lakes.

Splash stalactites: Stalactites that form when frothing lava flows through the lava tube, debris from the ceiling falls down and splashes lava onto the ceiling, or when lava flow rises and falls repeatedly, dipping at the ceiling. Splash stalactites can form new stalactites or merely cover preexisting stalactites. The dipping method produces symmetrical stalactites, while other methods of splashing create irregular jagged features.

Splattermites: A type of stalagmite that has upright protrusions that arc around the center of the splattermite. They form in caverns with tall ceilings where water falls faster and is more likely to bounce upon impact. Besides bouncing, the water must deposit calcite rather quickly before the water trickles down. These factors makes cool, dry cave entrances and tropical caves preferred locations for these towers of stone flowers.



Speleothems: Cave deposits of calcium carbonate and sulfates that decorate the walls, ceilings, and floors. The most common are stalactites and stalagmites, which are spires hanging from the ceiling and shooting up from the floor. When they meet, they form columns. Helictites are stalactites that grow in all directions, defying the laws of gravity in their formations. Water along sloping ceilings form draperies that ripple and curve, shimmering various colors depending on the mineral content of the water. Flowstones are thin sheets covering the walls and over ledges, but they require lots of water. If water makes its way to the floor, travertine rimstone dams may form, becoming rimstone pools if they fill with water. Rare, but beautiful, are gypsum flowers and sulfate deposits that form under dry passages beneath sandstone caprocks, where stalactites are incapable of forming.

Stalactites: Needles and spires hanging from the ceiling of a cave. They form along cracks in the ceiling where water seeps through and deposits calcium carbonate as it loses CO₂. Travertine soda straws indicate slow dripping water. Fast water forms stalactites as well as stalagmites underneath, forming a column if they meet. Stalactites do not form where harder rock covers the limestone.



Submarine Volcanoes: Underwater volcanoes created by movement and friction of tectonic plates. Volcanoes that grow tall enough break the water and form islands. Most islands are formed by submarine volcanoes

resulting from the subduction of an oceanic plate under another oceanic plate or a continental plate. Occasionally submarine volcanoes formed by rifting (plates moving apart) or slipping (plates moving laterally) also form islands. Examples: Anak Krakatau, Bora Bora, Iceland, Surtsey.

Sunken plunge pools: When lava lakes and pools cool, the surface cools first. The interior of the pool contracts as it cools, which sometimes results in the crust collapsing. A similar but more drastic effect occurs when the interior lava drains out.

Tarns: Lakes that are deep cirques filled with water.

Tower karsts: A landform based on sandstone or limestone riddled with caves, underground streams and passageways. Upheavals in the Earth's crust raise the ocean floor above sea level and expose the rock to erosive forces. Water and wind eat away the softer, more porous rock, turning fissures into tunnels and caves. Eventually the land becomes a plain checkered with towering turrets, pinnacles, and honeycombs of sturdier rock. Examples: Guilin Hills, Metéora, Monument Valley, Nam Bung Park, Ürgüp Cones.

Travertine dams: Terraces of travertine caused by water bearing calcium carbonate. There are three methods of formation. First, they can form by evaporation where nightly floods evaporate with the heat of the sun, leaving travertine behind. Second, they can form by rapid cooling of mineral-rich water from hot springs. Lastly, streams move slowly, allowing intermittent patches of swamp and vegetation. The plants release a chemical that dissolves calcium carbonate and forces it out of the solution. Under intense solar energy, the mineral hardens into travertine. The unifying factor in all methods of formation is the presence of terraces, where one pool can lead to the next. Examples: Band-e Amir, Jupiter Terrace at Mammoth Hot Springs, Pamukkale Springs, Strokkur.

Tubular lava stalactites: Stalactites that form from the release of gas rather than pure drip. As the ceiling lava cools, all the trapped gas pushes out, forcing part of the lava out and dripping into a stalactite. Initially the stalactites are hollow like soda straws, but they often fill up.

Upwelling lava: When lava flow is constricted in the caves, the lava can surge back or go through windows and entrances. Sometimes they pick up lava balls or boil through semi-solid floors above. There are even miniature volcanoes found in lava tubes where upwelling lava erupted through the floor.

Volcanoes: Where magma erupts at the surface and forms piles of volcanic rock. Volcanoes form where magma has access to the surface, either because of subduction and rifting or at volcanic hot spots. Volcanoes form on land and underwater (submarine volcanoes), and are generally conical with a crater at the peak. Where there are volcanoes, there are earthquakes, though most of them are imperceptible. Active volcanoes eject cinder, ash, pumice, tephra, lava, or any combination of these elements. Incidentally, pumice is the only stone that floats. Examples: Mount Fuji, Mount Vesuvius, Ürgüp Cones.

Waterfalls: Abrupt descent of a stream. While waterfalls vary in size and ferocity, a common phenomenon in waterfalls is undercutting. Undercutting occurs when the rock underneath the surface is softer than the rock on top. The turbulence of the falling water erodes at the softer rock, leaving the ledge of the waterfall unsupported. It will eventually fracture and place the waterfall further upstream. Examples: Angel Falls, Iguazu Falls, Niagara Falls, Victoria Falls.

Wetlands: Flat plains that are submerged in water for part of the year but are shallow enough to permit plant growth. They are usually found in coastal plains, broad river valleys, or recently glaciated areas and are result of mud



and silt deposits from rivers. Rivers flowing into the ocean can deposit enough mud and silt to form land, pushing salt water back and forming lagoons amidst sandy bars and muddy islands. However, if there is a strong ocean current, this cannot occur. In marshes, grasses, reeds, and rushes root in the soft sticky mud while their leaves break the water's surface for sunlight. In swamps the main vegetation are trees. Wetlands are important stops for migratory birds. Example: Everglades, Las Marimas, Mississippi Delta, Okefenokee Swamp.

Windows: Passages that connect different levels of lava tubes. The lower levels, often the last to cool, sometimes come up through the windows to shape the upper levels.

White sand deserts: White sand deserts derive from gypsum rather than silica, which gives sand its typical coloring. Though gypsum (calcium sulphate) is a common mineral, white sand deserts require lots of gypsum concentrated in one area before they'll develop. A combination of upheavals, erosion, gypsum-rich water, evaporation, and subsequent deposits of gypsum all led to the White Sands in New Mexico. Lake Lucero's surface has a crusty layer of glassy selenite crystals that powder when rubbed between fingers. This is the source of the White Sands Desert as wind erodes the crystals and replenishes the ever-moving white sands.

Places

Amazon River: Fed by Lake Lauricocha in the Peruvian Andes, the Amazon drains a flat-bottomed basin covering 2.5 million square miles. The basin is so flat that the gradient of the river rarely drops more than 1 inch per mile. Per second, the Amazon River flows ten times the amount of water than the Mississippi River does. The second longest river in the world, the Amazon deposits so much water into the Atlantic Ocean that it pushes the salt water more than 100 miles back, creating a huge freshwater lake in the ocean.

Angel Falls: The highest waterfall in the world, located in Venezuela. Angel Falls flow off Devil's Mountains (9,842 feet above sea level) and falls 3,210 feet (979 m.) total. The first drop is 2,650 ft., while the second is 560 ft. Together these two cascades are 18 times higher than Niagara Falls.

Ayers Rock: This massive block of sandstone found in Australia's Northern Territory is the remainder of mountain chain long since eroded. The climb to the top is 5,289 feet as the rock towers over the otherwise flat plain. The iron ore in the sandstone causes it to change color throughout the day: black to deep mauve during the night, reds and pinks at dawn, silver when it rains. The strata of Ayers Rock show the geologic history of the primeval ocean floor that once occupied the center of Australia 500 million years ago. Ayers Rock is worshipped by the Aborigines with paintings of religious scenes in the more sacred caves.

Bosque de Piedras: The forest of rocks found in the Peruvian Andes is a testament to water and ice erosion. Over the centuries, water and ice sculpted pinnacles and spires that rise out of the flat altiplano. Unlike tower karsts, these giant pillars are volcanic rock, much harder and resistant than sandstone or limestone. Some pillars reach as high as 300 feet.

Chocolate Hills of Bohol: Evenly rounded hills on a small island in the Philippines. These 1200 limestone hills are perfectly even, each 100-300 feet high stretching across 20 sq. mi. From above they look like eggs in a carton. They are usually emerald green, but during the dry season (February-



May), the vegetation dies, turning the hills brown, thus giving them their name. The inhabitants claim the hills are actually the tears of a mythical giant, spurned by the mortal woman he so dearly loved.

Chott Djerid: A large mudflat southeast of the Nefta Oasis. It doubles as a seasonal lake and floodplain for the Nefta Oasis's 152 artesian wells and springs. The land becomes a swamp of salty mud whose surface hardens as it's baked by the intense sun. Unknowing travelers soon find out the ground underneath is soft, not unlike quicksand. In the past, safe passage across the Chott Djerid was lined with trunks of palm.

Cueva de Villa Luz: Home to the cave of the snottities. Fed by the Lake of the Yellow Roses, the walls are covered by a gypsum paste, while the same substance hangs from the ceiling like viscous stalactites. This toothpaste-like goo carries acid-secreting bacteria with the corrosive strength of car battery acid (up to 0.0pH). The bacteria are chemosynthetic, using the natural chemical reactions to build cells. The cave has extreme levels of carbon monoxide, carbon dioxide, and hydrogen sulfide, which give the cave its rotten egg smell. These gases are so abundant that certain parts of the cave are dangerously low in oxygen, requiring humans to bring oxygen. As these gases interact with oxygen and water, the bacteria aid the chemical reactions and build cells at the same time, creating the acidic slime on the walls. Midges and fish eat the bacteria, while other insects eat the midges, creating a bizarre microecology that relies on sulfur rather than oxygen.

Death Valley: Located in California, it is the lowest and driest place in North America. Its lowest point, coming in at 282 feet below sea level, is a saltpan called the Badwater Basin. Once a lake full of flora and fauna, it is now a 10,000-year-old parched, cracked clay plain. It is also home to the moving rocks. Rocks dot the sparse landscape, leaving trails of hard mud in their wake. These rocks, some as heavy as 700 pounds, move by themselves, and no one is sure how. Some think runoff from the mountains and periodic torrential rainfall create muddy plains for movement by wind. Others think ice may move the rocks, forming mini-ice sheets in the frigid night that pushes the rock along. Moving up to 100 feet in a night, no one theory has prevailed. Along the Racetrack Playa, some rocks move in parallel paths, while others change course at varying angles.

Giant's Causeway: On the north coast of Northern Ireland, basalt columns line 900 feet of the coast and continue 500 feet into the sea. Each individual column is 15-20 inches across, shaped into regular polygons. Most are six-sided with the occasional four, five, or ten-sided column. The columns fit together so well, it looks like a stone-paved street from above. Formed from slow cooling lava, the basalt cooled faster on top, shrinking and causing cracks that worked their way down the entirety of the column. The formation is thought to extend inland, hidden by cliffs and green landscapes that have yet to be eroded.

Great Rift Valley: A huge chain of lakes, ravines, volcanoes, and seas in east Africa and the Middle East, stretching from Mozambique to Syria. Two plates are pulling apart in east Africa, tearing the Earth's mantle apart and causing the land along the boundary to subside. This tectonic motion opens the earth to molten rock, forming volcanoes.

Guiana Highlands: A range of huge flat-top mesas towering above the Amazon rainforest. Each sandstone mesa has sheer walls, cut out of the landscape like giant tower karsts. Steep cliffs, surrounding bogs, and fast-flowing rivers isolate mesas from the landscape and from each other, creating a unique ecosystem on each tabletop. With 100 mountaintops, the highest



flattop mountain is Mount Roraima at 9,094 feet. Guiana Highlands are also home to the tallest waterfall, Angel Falls. Falling in two cascades (2,650 feet and 560 feet respectively), the drop is 18 times larger than Niagara Falls.



Guilin Hills: Flat plains in southern China dotted with steep-sided pinnacles, limestone hills, and extensive cave systems below ground. Once the ocean floor, the Guilin landscape is mostly light, porous limestone, while harder rock caps the pinnacles. The limestone is deeply eroded and absorbs much of the rain and runoff, leaving the surface comparatively dry. The cave systems are often three dimensional, with underground sinkholes, caves, streams, and passageways. Besides running through the hills, the Xi River is also home to the cormorant fishermen, who use birds in their fishing.

Iguaçu Falls: On the border between Brazil and Argentina, the Iguaçu Falls consist of 275 individual falls. Formed from hard volcanic rock (basalt), the rocks often force the water around islands and into various channels. During the rainy season, the water flow of the falls is 2,812,500 gallons a second. The water decreases drastically during April to October, and every 40 years they dry up completely.

Keli Mutu: A volcano on the Island of Flores in the Pacific. Alongside the volcano are three differently colored crater lakes. Tiwoe Atu Polo (Lake of the Bewitched People) is a dark striking red due to the high iron salts in the rock. Tiwoe Noea Moeri Koooh Fai (Lake of the Young Men and Virgins) and Tiwoe Ata Mboepoe are green due to the sulphuric and hydrochloric acids. The Lake of Young Men and Virgins is an opaque green due to the volcanic vents that smoke when eruptions are eminent, whereas the other is a clear, transparent green. Though crater lakes of these colors are not unusual, finding all three in such close proximity is unique.

Lake Baikal: Located in southeast Siberia, Lake Baikal is the deepest and oldest lake in the world. Holding one-fifth of the world's fresh water, it is the result of tectonic scaring where a portion of the Earth's crust collapsed and formed a deep sheer-sided chasm. When it filled with water, Lake Baikal was born. With a maximum depth of 5,314 feet, it is home to numerous endemic species, many living in the deep. Lake Baikal will eventually link with the Artic Ocean, cutting Asia in two.

Lake Titicaca- A high-altitude lake in the Andes Mountains, nestled between parallel ranges in the Altiplano. Though the largest freshwater lake in South America, Lake Titicaca has high salinity due its drainage and high evaporation rate (due to high altitude, strong sun, and frequent winds). The lake is the mythical birthplace of the Incas and home to Uru Indians, who harvest the totora reeds for food, building homes and canoes, and creating artificial islands on the lake itself. The Indians live on tightly bound bundles of totora (nearly 2 m. thick). They build structures, plant crops, and harvest more totora on these islands.

Lechuguilla Cave: A deep cave in New Mexico rich in rare mineral formations. Closed to the public, only 100 miles of the cave have been mapped. Unlike most caves that are carved through surface runoff, Lechuguilla Cave is carved from the bottom up by rising springs. The water was rich in hydrogen sulfide, which formed the sulfuric acid that ate away the rock at a rapid rate. One notable room is the Chandelier Ballroom with selenite crystal up to 20 feet long and branching throughout the entire room.



Mammoth Cave: The longest cave in the world with the cave entrances in Kentucky. Its mapped passages are more than 300 miles. Due to its formation, the oldest passages are in the front of the cave and branch into 3 to 5 major branches. Pre-Columbian Indians made the cave their home around 2000 B.C. but abandoned the caves around the time of Christ.

Matopos Hills: Home of the balancing rocks in Rhodesia. The balancing rocks are of different sizes, stacked at precarious angles and sometimes appear to defy physics. Glaciers brought large granite boulders in their advance and stranded them in their retreat. Weathering and erosion shaped these granite boulders and their surrounding rock, forming granite outcrops. Although some formations look like one good shove would topple the whole column, these stones have withstood millennia of erosive forces. The San of the area built structures mimicking these granite outcrops, used them for burial grounds, and created Bantu shrines at these sites.

Metéora: On the plain of Thessaly in northern Greece, 24 giant rocks shoot out of the ground to soaring heights. Once the seabed, these pillars were eroded by water, wind, and extreme temperatures. Some reach 1,800 feet tall, while others are a few hundred feet tall. They are home to ascetics and monks that built in the hollows and fissures of the rock. The sheer cliff walls promoted their ideals of solitude while also offering them protection in more uncertain times. Once home to 24 monasteries, only five are still inhabited.

Niagara falls: The waterfall between Lake Erie and Lake Ontario. The average flow of Niagara is 1.25 million gallons (5.7 million liters) a second. The absence of sediment and sand create the pure white mist and spray that covers the falls. Niagara Falls recedes as the turbulence from the falls cuts back into the soft shale and sandstone. Eventually, the unsupported rock at the top of the falls fractures and falls. Both the US and Canada divert water for hydroelectricity, lessening the erosion of the falls.

Ngorongoro Crater: 100 square miles of grassland in present-day Tanzania formed by an extinct volcano that collapsed. Once volcanically active during the formation of the Great Rift Valley, the floor of crater lays 2,000 ft. below the rim, and its grasslands support numerous wildlife, including lions, hyenas, zebras, wildebeests, elephants, and hippos. Two rivers feed the crater's swamps and soda lakes. The brine lakes are favored breeding sites for flamingos, since few birds can stand such saline levels.

Okavango Delta: A large wetland surrounded by the Kalahari desert. Spanning over 6,000 sq. mi., the Okavango delta is the river that never finds the sea. It is the last remnant of an ancient water system that has since dried up over time due to rifting and climate changes. Areas close to the river are perennial swamps, while drainage areas further out become sandbanks and salt pans during the dry season. Even during the dry season, subterranean water flows, though few plants and animal can access the deep water table. In the drier regions, this juxtaposition of water and desert create unique life for permanent residence with unique adaptations. Plants retain moisture in their leaves and roots, while other develop large tubers, one as heavy as 260 kilograms holding 200 liters of water. Many creatures are nocturnal or burrow their homes. In the wet regions (Panhandle), papyrus and palm accompany hippos and crocodiles. Because of its abundant water, the Okavango has long been a haven for animals, vegetation, and people.

Olgas: The uplifted remnants of an ancient mountain chain on the bottom of the ocean that has since been eroded into a string of giant domes. Found in Australia, the tallest of the 30 domes is Mount Olga, peaking at 3,509 feet. The aborigines revere the rocks and look to their caves as a source of shelter,



hunting, and fresh water. Cave paintings and other remnants reveal the San have known about the rocks for 40,000 years.

Pamukkale: Along the side of Cal Dagi Mountain in Turkey, snow-white cliffs of travertine step down from the hot spring. The steps of the terrace are actually warm pools of mineral-rich water supported by a wall of fluted travertine rock. The hot water floods the cliffs at night, and the heat of the day evaporates the water, depositing more travertine in its place. The hot spring deposits 148,500 cubic feet of travertine a year.



Ruwenzori Mountains: These mountains in central east Africa are the beginning of the White Nile River. Unlike the other mountains in the region, they are not formed from volcanic activity, but from drastic uplift due to tectonic movement. Though located at the equator, it is home to extensive glaciers and glacial lakes. The range has nine peaks over 16,000 feet, though they are rarely seen behind the thick clouds and dense mist. The mountain receives moist air coming off the Congo Basin, resulting in two meters of precipitation a year. This intense moisture alongside ample year-round solar radiation creates swamps and marshes in the foothills, lush evergreen zones further up the base, and giant vegetation in the upper slopes beyond the tree line. Some vegetation grows up to 20 times their traditional height in these favorable conditions. The Ruwenzori are also known as "The Mountains of the Moon."

Sudd: The marshy area fed by the White Nile before it joins the Blue Nile. This marsh absorbs so much of the White Nile's flow that it only contributes a fifth of the water in the annual flooding of Egypt. The Sudd is 251,000 square miles of papyrus and lotus.

Surtsey: An island off the coast of Iceland that formed from an underwater volcano. For two days in 1963, a column of gas, steam, scoria, and ash shot into the air. After the eruption, an island of volcanic fragments emerged. Islands of this nature are usually eroded away, since they are formed from fragments piled together and not from liquid lava that solidified. Fortunately for Surtsey, a subsequent eruption the following year formed a cone around the island, allowing the underwater volcano to spew liquid lava, bonding the volcanic fragments of Surtsey together.

Tepuis: Flat-topped, sheer-sided mountains where the borders of eastern Venezuela, Brazil, and Guyana meet. Hard, volcanic rock on top of a sandstone plateau protected the lower layers from erosion, while more sandstone formed on top of the metamorphic rock. Over geologic time, the plateau split apart, and the sandstone on top of the metamorphic rock eroded, creating flat summits with sheer sides that are widely dispersed. Each of the tepuis is isolated from each other, and they support flora and fauna unique to their mountaintop. Mountaintops vary; some are thickly forested, pitted with hollows and bogs, coated with sharp contorted rocks, or covered with pillars and arches. Others have deceptive black rocks that look like metamorphic rock, but are actually eroded sandstone covered with black algae.

Ürgüp Cones: Located in central Turkey, these cones, pyramids, needles, and honeycombed cliffs have been home to peasants and religious men for over 2,000 years. Volcanic material covered the area with horizontal layers of lava, ash, cinder, and mud. Water and weather eroded the landscape until all that remained was tufa (made from ash) protected by black basalt boulders (formed from cooled lava). These pinnacles were carved out to make homes, churches, and whole communities. Uneven flights of stairs,



thick insulated stone walls, and carved windows and doors mark generations of inhabitants, while agriculture on the volcanic soil thrives with proper irrigation.

Witsand: An island of white sand dunes in the Kalahari Desert. The island is six miles long and two miles wide, remaining separate from the red sands of the Kalahari. A row of quartzite kopjes traps the sands blowing from the Kalahari, building a low sand mountain. Water trapped in the quartzite seeps into the sand, bleaching it white or gray-blue. Among the white sand dunes are fulgurites, misshapen stalagmite-like formations made of fused sand particles when lightning struck the sand. Local superstition treats these white dunes with caution.

Yucatán Peninsula: Home to the theoretical location of the crater that ended the Cretaceous Period and brought 50% of all species to extinction, notably large land animals. With no surface stream draining into the ocean, all the water drains through underwater caves and channels. Throughout the peninsula, there are vertical shafts filled with water (cenotes) that lead into these caves. The Mayans gathered their water from underground caves and cenotes and built their monuments on top of or near cenotes, considered sacred to the ancient religion.

Valuables

All prices listed are approximations. Adjust prices as needed. Generally, prices will be lower the closer to the production source.

Adamantine: Adamantine is a very hard metal found in a few, very precious veins and in some meteorites. Adamantine veins are always deep, so only subterranean societies typically mine for adamantine. Every millennia or so, a surface adamantine vein is found. These veins usually play out after producing only a few hundred tons of useable adamantine. This is often enough, however, to dictate the rise and fall of some societies. Adamantine is a rare metal in that it also has no set color. It is often found in small amounts in a mithral vein. **Climate/Terrain:** Underground or mountains. **Value:** 2,000gp/lbs.

Allspice: Allspice is a short, smooth barked tree with impressive foliage. Little white flowers show from among the leaves and the tips of branches hang with bunches of green berries resembling peas. These fruit are picked, placed in a bag to sweat a few days and then sun-dried on broad platforms for five to ten days. Allspice is impossible to transplant from its native region, so it is a very valuable spice. **Climate Terrain:** Warm wet mountainous forests. **Value:** 8gp/lbs.

Amethyst: Purple amethyst is a variety of quartz. The finest crystalline amethyst occurs in gas cavities (geodes) in volcanic rocks. **Climate/Terrain:** Mountains, hills, or underground **Value:** varies (usually around 100gp each).

Anise: Anise grows to almost two feet in height and is characterized by a long, green stem topped off with white, fluffy flowers, which appear during the summer months. As the flowers die, small brown seeds that are hairy and sweet to eat soon follow. Even though the plant grows mostly in warm climates that have dry air and mild winters, the plant has been exported to colder climates with moderately successful results. However, in such instances, the seeds only ripen during warmer-than-average summers. The plant's flowers exude a pleasantly fragrant scent. Anise seed is an extremely popular spice, so much so that small kingdoms can sustain themselves on exporting the seed to lands where it doesn't grow. **Climate/Terrain:** Any dry, warm land. **Value:** 3gp/lbs.

Barley: Barley is a staple grain. Barley is often eaten as porridge or ground into flour. It is one of the earliest cultivars and is used to make beer as well as eaten. It is a hardy crop that can grow in most locations. It has good calcium



and magnesium levels, but its yield is less than wheat. Barley is usually grown as a secondary grain crop for three main reasons: it helps reduce catastrophic failure through single crop dependence; it is easily used to make beer; and it has a shorter growing season than wheat and can be grown at higher altitudes. Barley can also be grown in light soils under which wheat performs more poorly, but both barley and wheat require at least 40°F to grow. Climate/Terrain: Any but the coldest/wettest. Value: 1cp/2lbs.

Beaver: Large rodents, beavers live mostly in cold coniferous forests where they construct elaborate burrows in ponds they create by damming rivers with trees they chew down. Beavers eat trees and store winter food underwater. Their pelts are valuable and shed water well. They live in adult pairs and several previous years' worth of young. Climate/Terrain: Cold forests near water. Value: 2gp/pelt.

Brass: Brass is an alloy of copper and zinc. It has a pleasing color and is often used for decorative purposes. Climate/Terrain: Mountains, hills, or underground Value: 3sp/lbs.

Bronze: Bronze is an alloy of copper and tin and is harder than copper alone. It was used for weaponry before more advanced metallurgy techniques developed. Climate/Terrain: Mountains, hills, or underground Value: 3sp/lbs.

Cacao: A 40-foot tall evergreen tree, cacao is valuable for its seeds, which are roasted and pulverized to make chocolate and cocoa. The seeds contain much fat and the mildly stimulating alkaloid, theobromine. Cocoa is obtained by removing most of the fat, called cocoa butter, and chocolate results when most of the fat is retained. The Inca used cacao seeds as a currency. Climate/Terrain: Warm, wet forest. Value: 10gp/lbs.

Caraway: Caraway is the botanical cousin of cumin. Like cumin is a small plant, but with fruits slightly smaller than that of cumin. It's milder in taste and is not as long lasting. Caraway is often called a cold-country spice and is typically used in breads like pumpernickel and in cabbage soups. Caraway is used in several cheeses like Gouda and Munster. It is also used in some grain alcohols to add a unique taste. Climate/Terrain: Temperate grasslands and warmer cold grasslands. Value: 5gp/lbs.

Cardamom: Cardamom is a clumpy plant with long green glittering leaves on long stalks. At their base bloom splendid cluster of mauve and whitish-pink flowers which give place to fruits that resemble small shiny olives. The fruits are collected August through April by hand and then dried in the sun. Good cardamom possesses slightly knobby pale green capsules that protect the tiny, soft black berries within. Climate/Terrain: Warm wet mountains. Value: 13gp/lbs.

Cinnamon: Cinnamon a large woody shrub usually kept at no more than six feet in height. Its bark is peeled off the thin (less than one inch in diameter) branches right after the rainy season. The bark is then dried and eventually ground into powder before being used as a spice. Cinnamon is a very old spice and has been transported throughout the world for millennia. Climate/Terrain: Warm monsoonal grasslands. Value: 1gp/lbs.

Cloves: Cloves are the buds of a tall (40ft.) tree. The buds are picked just as they begin to turn pink and then they are dried for three days. The buds then turn into hard little nails familiar throughout the world. Clove oil has strong antiseptic powers. It is an anti-bacterial, an anti-fungal, and an analgesic. It is commonly used to treat toothaches and makes its way into smoking tobacco to add a rich flavor and a tingly feeling. Clove trees can be transplanted, but it is very difficult. Climate/Terrain: Warm wet forests. Value: 15gp/lbs.





Coffee: Coffee comes from one of three main trees: the Arabian, the Liberian, and the Congo coffee trees. They group up to 30-50 feet tall, and the fruits are at first green but become bright red and finally purple. These fruits are husked to reveal the beans that are ground to produce coffee. Climate/Terrain: Temperate forests. Value: 10gp/lbs.



Copper: Copper is a very common metal found mostly in chalcophyrite and bornite. It is found in large isolated ore deposits or in massive low-grade depositional areas. Copper is easy to shape and is alloyed with zinc to make brass and with tin to make bronze. Climate/Terrain: Mountains, hills, or underground Value: 5sp/lbs.



Coriander: Coriander is an annual herb that belongs to the carrot family. The unripe fruits have a smell that has been compared to that of bedbugs. However when ripe, the seeds have a distinctive sweet citrus/mint/musty aroma and have been an important spice throughout history. Coriander is also used for its leaves (often called cilantro). The bright green plant reaches heights of 16 to 24 inches with small white or pink flowers. Climate/Terrain: Temperate or Warm grasslands or hills. Value: 5sp/lbs.

Cumin: Cumin is the little seed (1/5 of an inch) of a plant around a foot high which sets its pale pink flowers in graceful umbels on frail stalks that undulate in the warm breeze. Cumin is a very old spice native to mediterranean climates. It's often used in breads, falafels, beans, soups, and spiced meats. Climate/Terrain: Warm temperate and warm grasslands. Value: 5gp/lbs.



Diamond: Diamond is the hardest of all known minerals. It ranges in color through yellow, brown, pink, green, and blue. Red diamond is very rare. Diamonds are found on the surface as crystal fragments in river gravels off of volcanic drainages. Underground they are found mostly in kimberlite source rocks in volcanic pipes with roots between 100 and 200 miles into the earth. Climate/Terrain: Mountains, hills, or underground Value: varies (usually around 5,000gp each).

Electrum: Electrum is often called "white gold" and it is a mix of silver and gold. Electrum is rarely found naturally. Climate/Terrain: Rarely found in mountains, hills, or underground Value: 25gp/lbs.

Emerald: Emerald is the green variety of beryl. It is found on the surface as crystal fragments in river gravels. Underground they are found mostly in veins with calcite and pyrite (fools gold). Climate/Terrain: Mountains, hills, or underground Value: varies (usually around 1,000gp each).

Ermine: This little (barely 1 foot) carnivore's pelt is used to trim coats, stoles, and neckpieces. It's a fierce little creature, attacking creatures much larger than it. Climate/Terrain: Cold forests and scrublands. Value: 7gp/pelt.

Fox: Foxes are clever carnivores, and their fur has always been in demand. They're usually solitary hunters (sometimes mated pairs will hunt) who prey mostly on small vertebrates. Climate/Terrain: Cold and temperate forests, scrublands, and marshes. Value: 7gp/pelt.

Garnet: Garnet is a group name for a set of gems: almandine (red and purplish red), pyrope (red and purplish red), spessartine (orange red), grossular (orange, green, or colorless), and demantoid (green). Garnets have been carved into broaches, diadems, and cameos throughout history. Garnets are usually found in igneous rocks. Climate/Terrain: Mountains, hills, or underground Value: varies (usually around 100gp each).

Ginger: Ginger is a rhizome with a multitude of knobby protuberances. The plant resembles a reed that stands over three feet tall and sports a



panoply of long, tapering, sword-shaped leaves. The rhizome is harvested once the leaves begin to fade and is cleaned and set out to dry for three or four days. Ginger is often pickled, dried, spiced, and sugared. Climate/Terrain: Warm wet grasslands. Value: 2gp/lbs.

Gold: Gold is the noble's metal. Gold is, ironically enough, gold in color and very soft. It is found in stream deposits and in smaller sized chunks (called grains) in gravel and sand. Gold is also found in veins both on the surface and underground. It is often found in underground quartz veins. Climate/Terrain: Mountains, hills, or underground Value: 50gp/lbs.

Iron: Iron is a very common metal found in hematite ores. Iron is very tough and hard, yet easy to work. It can be cast, forged, rolled and alloyed with other metals. Climate/Terrain: Mountains, hills, or underground Value: 1sp/lbs.

Ivory: Ivory is the hard, smooth yellowish dentine forming the main part of the tusks of the elephant. A similar substance forms the tusks or teeth of other animals, such as the walrus and the hippo. Ivory is a very durable substance that is used for creating carved works of art or for tools in places where wood is scarce. Ivory's value is dependent upon the size of the piece in a manner similar to gems: larger pieces are more valuable than their mere weight would suggest. Climate/Terrain: Wherever elephants, hippos and walruses are found. Value: 10gp/lbs.

Jade: Jade is actually two different types of stone. The rarest type, jadeite, may be white, orange, brown or lilac. The most prized jadeite is a translucent emerald-green variety called "imperial jade." Nephrite, the other jade, is more common and is used for larger jade sculptures or ornamentation. Jade is a tough rock that can even be used for weapon handles. Jade is usually found as weathered boulders and cobbles in stream deposits or in glacial sediment. Underground jadeite is usually found in nodules in serpentinite. Nephrite is also found underground in serpentinite, but at much greater frequencies. Climate/Terrain: Mountains, hills, or underground. Value: varies (usually 100gp each)

Lapis Lazuli: Lapis lazuli is a vivid blue gemstone composed of lazurite and sodalite with smaller amounts of white calcite and specks of brassy colored pyrite. The best varieties are found in white marble veins. Climate/Terrain: Mountain, hills or underground. Value: varies (usually 10gp each)

Lead: Lead is found mostly in galena ore. It is the densest and softest common metal and is very resistant to corrosion, but it is not very strong. It is worked mostly from limestone deposits and it is often found in conjunction with silver deposits. Climate/Terrain: Mountains, hills, or underground Value: 5cp/lbs.

Mace: Mace is a deep red membrane that cradles the stone in the middle of a nutmeg fruit. Within the stone lies the nut that is the nutmeg spice. Mace covers the stone in a netlike formation. Mace is carefully cut from the stone and sun-dried for several days until it changes color from the deep red into an orangey brown. It is then used whole or ground. Mace tastes similar to nutmeg, but is more pungent and doesn't stain foods as much as the brown nutmeg. Climate/Terrain: Warm wet forests. Value: 12gp/lbs.

Maize: Maize (also known as corn) is a staple crop. The maize plant is a tall, annual grass. It has deep roots and requires abundant moisture for ideal development, but it can survive and produce well under dry conditions. Although it is a hardy plant, it does require at least 50°F to grow. Maize seed return is massive compared to other grains: a 1 to 150 return is not unusual. This often provides cultures relying upon maize a significant population advantage. Climate/Terrain: Temperate and Warm grasslands or hills. Value: 1cp/2lbs.





Manioc: Manioc is also known as cassava or tapioca. It is a plant whose starchy roots are prepared much like potatoes. They can be toxic uncooked, and they are often grated and squeezed to extract the potentially poisonous sap. They are then dried and made into a meal much like flour. Manioc can also be fermented to create alcoholic beverages. Manioc is a very useful staple crop that requires at least 8 months of warm weather to grow. Climate/Terrain: Warm grasslands (savanna) and Warm Forests. Value: 1cp/2lbs.

Marten: Martens are arboreal weasels with valuable pelts. Climate/Terrain: Cold and temperate forests. Value: 4gp/pelt.

Mink: A semi-aquatic weasel, minks spend a lot of their time foraging in the water for mollusks, crustaceans, and fish. It has very soft fur. Climate/Terrain: Cold and temperate waterlines. Value: 6gp/pelt.

Mithral: Mithral is a very hard silvery metal usually found deep underground. Some mithral veins contain small amounts of adamantine. Climate/Terrain: Mountains, hills, or underground Value: 1,000gp/lbs.

Muskrat: A large rodent with dark, glossy fur. It is found in fresh, brackish or saltwater marshes, ponds, lakes, and rivers. Climate/Terrain: Cold and temperate waterlines. Value: 1gp/pelt.

Nutmeg: Nutmeg trees stand thirty or forty feet high, have dense green foliage with tints of gold, and bear flowers and fruits throughout the year. The fruits are about the size of a small apple and turn from green to ivory yellow. When ripe, the fruit split in two to reveal its treasure. The stone of the fruit contains the nut and around the stone is the deep red aril more commonly known as the spice mace. Within the stone is the nutmeg proper. Enterprising cultures soak the nuts in limewater before exporting them, thus ensuring they cannot germinate and threaten a very lucrative trade. Climate/Terrain: Warm wet forests. Value: 11gp/lbs.

Oats: Oats are a staple crop cultivated for its grain as well as for fodder. Oats are usually eaten as porridge or ground into flour and mixed with wheat. Oats are long-day plants and thrive on a wide variety of soils. Oats are very hardy and require only 40°F to grow. Climate/Terrain: Temperate grasslands, hills. Value: 1cp/2lbs.

Opal: Opal looks much like mother of pearl and comes in clear, milky, gray, or black. Opals show a bright rainbow of colors (blue, green, yellow, and red) because of the tiny silica spheres inside the mineral. Most opal is formed over a long period of time in sedimentary rocks, but some opals form in gas cavities in volcanic rock. Climate/Terrain: Mountains, hills, or underground Value: varies (usually around 1,000gp each).

Otter: Otters are playful aquatic carnivores' whose fur has long been in demand. Climate/Terrain: Cold and temperate waterlines. Value: 8gp/pelt.

Paprika: Paprika is a mixture of ground mild red peppers. It is often sweet and used to color all sorts of dishes like potatoes, ragouts, vegetables, meats, fishes, sheep-milk cheeses and more. Climate/Terrain: Temperate or warm grasslands or hills. Value: 1gp/lbs.

Pepper: Pepper grows in long, thick bunches on a creeper. Pepper naturally grows on trees like coconut, palms, jackfruit or other trees occasionally sport a pepper creeper, and their sparse canopies allows the sun to filter down and ripen the little bunches of pepper fruit. The peppercorns are detached by hand when still green and not quite ripe. The bunches are then put out to dry for several days until they shrivel and adopt the familiar puckers and dark color. Pepper is a spice used throughout history and is traded far and wide. Climate/Terrain: Warm wet forests. Value: 2gp/lbs.



Peppers (spicy): Spicy peppers are staple foods for some cultures and exotics spices for others. The heat in the peppers is a chemical defense to reduce animal predation that has ironically increased predation by many intelligent species. Over a hundred different spicy peppers exist and they are usually preserved by drying, although some are pickled to create hot chutneys. Climate/Terrain: Temperate and warm grasslands or hills.

Peridot: Peridot is a transparent green gem variety of olivine, a mineral common in basaltic lavas and some deep-seated igneous rocks. The most valuable stones are golden-green and deep-green colored. Climate/Terrain: Mountains, hills, or underground Value: varies (usually around 50gp each).

Platinum: Platinum is a silvery metal that is very hard. It is common found in a variety of minerals with the most common being sperrylite. Most platinum minerals occur as very small grains in nickel deposits, but platinum grains are also commonly found in gold workings. Very rarely, large nuggets of platinum are found. The largest recorded weighs 21.4 lbs. Climate/Terrain: Mountains, hills, or underground Value: 500gp/lbs.

Potato: Potatoes are a staple crop. They are eaten boiled, baked, fried and stewed. They can be ground, dried, and made into flour. They can also be made into alcoholic beverages. Potatoes require only 40°F temperatures to grow. Climate/Terrain: Any hills, grassland, or forest. Value: 1cp/2lbs

Rice: Rice is a grass whose fruits help feed the majority of humanity. Rice grows to around 3 ft. tall and requires a lot of water to grow, as flooding the paddies is necessary. Rice has a high yield, more than any other staple besides maize. Climate/Terrain: Warm wet grasslands, hills or mountains (terrace farming). Value: 1cp/2lbs.

Ruby: Ruby is the red variety of corundum. It is found on the surface as crystal fragments in river gravels. Underground it is commonly found in any volcanic rock, alkali basalts, kimberlites, lamproids, and lamprophyres. Climate/Terrain: Mountains, hills, or underground Value: varies (usually around 1,000gp each).

Rye: Rye is a staple grain, used to make flour. It is an extremely hardy grain, often grown where other grains will not grown. It is also often used for fodder and silage. It thrives in infertile areas and is renowned for it's ability to grow on sandy soils. Climate/Terrain: Any grassland. Value: 1cp/2lbs.

Sable: A mustelid (like otters, minks, martens and weasels) whose fur is highly valued. It is primarily a predator of mice, chipmunks, squirrels, small birds and sometimes fish, but it also eats fruits. Climate/Terrain: Cold forests, grasslands, hills, and mountains. Value: 10gp/pelt.

Saffron: Saffron is the unchallenged emperor of spices. The only spice that comes from a flower, saffron comes from the night-blooming, mauve flower *Crocus sativus*. The flowers three red stigmas are removed and dried and then either used whole or crushed. A pound of saffron requires at least 60,000 flowers. Before long distance trade routes became more of a commonplace occurrence, saffron was often worth more than its weight in gold. Saffron is used in breads for celebration purposes and in risottos for a rich dining experience. Climate: Warm or temperate (no hard freezes) grasslands. Value: 15gp/lbs.



Salt: Salt is a mineral required by mammals. It is found in a natural crystalline form called halite. It is often deliberately harvested/mined by humans for trade or consumption. Two typical ways of doing so is through flooding a low-lying area with sea water and then letting it evaporate leaving the salt behind or by going to an ancient sea bed (now a salt flat)



and prying out slabs of salt. Climate/Terrain: Mountains, hills, desserts, coasts, or underground Value: 5gp/lbs.

Sapphire: Sapphire is the blue variety of corundum. It is found on the surface as crystal fragments in river gravels. Underground it is commonly found in any volcanic rock, alkali basalts, kimberlites, lamproids, and lamprophyres. Climate/Terrain: Mountains, hills, or underground Value: varies (usually around 1,000gp each).

Seal: Seals are cold-water mammals whose young often have luxurious coats. Climate/Terrain: Cold seas and cold sea shores. Value: 2gp/pelt.

Silver: Silver is a common precious metal. It tarnishes easily and is much less valuable than platinum or gold. Silver is usually found in conjunction with lead deposits or with copper deposits. Silver is easily workable and tougher than gold so it is commonly used for durable jewelry. Climate/Terrain: Mountains, hills, or underground Value: 5gp/lbs.

Sugar: Sugar comes from the sugarcane. This 9-15ft. tall plant gives a sugary juice when crushed, and this juice is boiled down and dried to form sugar. Sugarcane also produces molasses and is an important part of rum production. The young plant can be eaten raw or cooked, and the plant's reeds can be used to make thatch, mats, and screens. Sugarcane only grows in the tropics and subtropics with hot, humid climates alternating with dry periods. Climate/Terrain: Warm grasslands or hills. Value: 5gp/lbs.

Taro: Taro is a root crop, similar to manioc and yams. It is most commonly known as poi (the traditional staple food of native Hawaiians). Taro contains an irritant that is removed during cooking. Taro is usually eaten peeled and boiled or fried, like potato chips. Taro is also crushed, dried, and made into flour. Climate/Terrain: Warm grasslands, forests, or hills. Value: 1cp/2lbs.

Tea: The tea tree can grow up to 30 feet, but it is usually trimmed under cultivation to maintain a low and shrub-like profile. Tea leaves are picked and dried promptly to create green tea or are picked and fermented to create black tea. Tea contains the alkaloid theine, a stimulant, an astringent, and a nervine. It also contains tannin, which is responsible for the bitter taste of the beverage if the tea is brewed too long. Climate/Terrain: Temperate or warm, wet forests (usually mountainous). Value: 10gp/lbs.

Tin: Tin is found in cassiterite and is hard, heavy, and difficult to scratch. Tin has a low melting point and does not corrode easily. Pewter, commonly used for figurines and sculpture, is an alloy of roughly 75% tin and 25% lead. Climate/Terrain: Mountains, hills, or underground Value: 1sp/lbs.

Topaz: Topaz is a gem found in several colors: colorless, pale blue, pink, or the most valuable, golden yellow called "imperial topaz." Topaz is found mostly in granites and pegmatites, and some gem-quality topaz crystals weigh several pounds. Climate/Terrain: Mountains, hills or underground. Value: varies (usually 500gp each).

Tourmaline: Tourmaline has the greatest color range (yellow, green, blue, pink, brown, mauve-gray, "watermelon," graduating colors) of any gemstone and some single crystals are multicolored. Tourmalines are often cut into fanciful shapes such as leaves to show off their graduated colors. The best tourmalines are found in pegmatites. Climate/Terrain: Mountains, hills or underground. Value: varies (usually 100gp each).

Turmeric: Turmeric is a large-leaved herb whose rhizome is ground to make the yellow spice commonly called turmeric or tumeric. It is mainly used in conjunction with other spices (in curries). Climate/Terrain: Warm grasslands or hills. Value: 5gp/lbs.



Vanilla: Vanilla is a creeper plant that climbs up tropical trees (casuarina or vacoas) and flourishes in the heat and damp shade. The fruits appear a month after pollination and are left to ripen, a process that takes seven or eight months. The fruits look like oversized green beans when they are harvested. After harvesting they are blanched in 125°F water for three minutes to halt vegetative reproduction. They're then left to sweat in wool-padded crates for twelve hours or so. After tanking they're dried alternatively on racks and in an oven for a week before being placed in the sun a few hours a day for an additional week. The pods are then closeted away in greaseproof paper lined crates for eight months. Especially valuable vanilla is left in the crates for an additional two years, in which time it is frosted with tiny white crystals of pure vanillin. Vanilla is pollinated by a limited number of species, and when removed from its natural environment, it must be hand pollinated or it will not produce pods. Climate/Terrain: Warm wet forests. Value: 13gp/lbs.



Yam: Yams are a staple root crop that are usually baked, boiled, or mashed. They have a long dormancy period that allows them to store well. They are usually trellised aboveground to ensure greater yield. Climate/Terrain: Warm grasslands, hills, and forests. Value: 1cp/2lbs.



Wheat: Wheat is the most familiar grain to many people. It is a grass whose grains are ground to make bread. Its grains are also used to make beer and other alcoholic beverages. Its straw is used to make mats, baskets and fodder. Wheat requires 40°F to grow and favors dark soils rich in nitrogen, cloudless warm days, and well-distributed low levels of rainfall. Climate/Terrain: Temperate and warm grasslands. Value: 1cp/lbs.

Plants

Arctic willow: A species of tree on the Arctic tundra that stands a few inches tall.

Banyan tree: A tree that grows aerial roots and creates multiple trunks. It starts with a single trunk with another tree. It grows aerial roots toward the ground, supporting and feeding the parent branches. Banyan trees continue to grow more secondary roots, expanding the territory of the tree. Banyans create small forests that long outlive the parent tree, the most famous in Calcutta covering 243 acres. Banyans are sacred trees in India, planted near temples.



Baobab tree: Inhabiting arid environments, the Baobab tree has a bulbous trunk with razor-sharp spines amid its leaves and branches. They are as fat as they are tall, with an average diameter of 33 feet and a height of 39 feet. Its roots spread out in each direction for 300+ feet. Storing water in the soft fibrous wood in its truck, a baobab tree stores up to 22,000 galleons of water during the rainy season. During the dry season, it sheds its leaves to avoid evaporation and waits for the rain to return, when it sprouts white flowers and produces fruit. Its pulpy fruit, referred to as monkey fruit, is high in vitamin C. Some ambitious people have excavated the baobab for shelter.

Bird's nest fungus: A small cup-like fungi 5 mm in diameter with 4-5 capsules that carry its spores, resembling a bird's nest filled with eggs. The capsules are attached to the nest by a stalk. When rain strikes the nest, it launches a capsule out of the nest and breaks the outside of the stalk. Inside the stalk is a sticky rope that can stretch up to 8 inches long, grounding the flying capsule to a nearby branch. The capsule winds its way around the branch like a tetherball and hangs from the tree. When it dries, the capsule will burst, releasing the spores into the air.



Blood flower: A milkweed whose sap is lethal to insects. It secretes a milky rubbery liquid when its leaves or stems are damaged. It also attracts bees with its fragrant nectar and traps them in a chamber. The strong bees escape, but not before the blood flower drops its pollen sac.



Brazil nut tree: Found in South American rainforests, these trees rely on the orchid bee for pollination. It produces nectar in a coiled hooded area, so only strong large bees (orchid bees) can lift the hood and obtain the nectar. As the bee's body rubs against the hood, it picks up pollen and distributes it from flower to flower. Its fruit is a cluster of brazil nuts in a casing. The lid of the casing breaks open when ripe, exposing the brazil nuts. A small rodent known as the agouti is one of the primary predators and disperser of the brazil nut. It breaks through its tough shell, but in times of plenty, agoutis bury brazil nuts for later and often forget where they are buried.

Calabash tree: A tree found in rainforests in Central and South America and the West Indies. Pollinated by bats, their flowers are scentless during the day and exude a strong smell of sweating cheese at night, which is attractive to bats. Native people use their pulpy fruit, found inside hard green woody shells, for medicinal purposes.



Carnivorous Pitcher Plant: These natives of the rainforests supplement their photosynthetic diet with insects and small animals. Though each species has developed differently, all carnivorous pitcher plants have a pool of digestive juices and bacteria, consuming those who fall in. They look like pots of varying sizes, some growing 30 feet tall with pitchers 12 inches in length. The pitchers are usually green, sometimes with red insides. Some species develop a lid to close in creatures, while others have sweet nectars to entice insects. The *heliophora heterodoxa*, thought to be one of the first carnivorous plants, has a spoon at the top of the pitcher that contains slightly narcotic nectar. The cobra lily is a pitcher plant incognito. It has the appearance of a striking cobra with nectar in the "fangs" of the plant. Insects enter and become disoriented, eventually falling into a pit of digestive juices deep in the pitcher. Pitcher plants also eat small mammals and reptiles that fall in or those that attempt to steal the insects crammed in their pots.



Cercropia tree: A rainforest tree that live symbiotically with ants and scale insects. Scale insects eat the sap of the tree and excrete honeydew. Unfortunately, scale insects cannot penetrate the bark of the tree. Ants live inside the hollow branches of the Cercropia tress and farm scale insects because they eat the honeydew they excrete, while giving them access to the Cercropia's sap. The tree leaves protein-rich capsules and nectar at the base of its leaves for the ants that in turn protect the tree from other predators. Cercropia trees do not have chemical defenses like so many other rainforest plants because of their mutualistic arrangement.

Coryanthes orchids: These orchids create a trap for pollinating insects. They make fragrant-smelling nectar that attracts male bees. The fragrance compounds have a narcotic effect, causing the doped up bee to fall into a well (formed by convoluted petal growth). The only path out is lined with pollen, which he will deposit at the next flower he visits. Unfortunately, drugged bees sometime take up to 45 minutes to find the way out.



Cuscuta: Parasitic plants that sweep the floor looking for a host plant. Once one of its stems find a host, they curl around it and constrict. This signals more stems and suckers that clamp on the host's tissue, injecting toxins. Cuscuta abandon their roots to feed off their prey, finding another after it dies or dying with their host. Should two cuscuta stems meet and inject each other with poison, nothing happens, but many viruses transmitted by these parasitic tangles are responsible for serious crop damage across Europe.

Cycad: When native to rainforests, this leafy plant produces a highly toxic poison, warding off insects, animals, and humans alike. In Costa Rica, the caterpillars of the lycaenid butterfly eat the leaves of the toxic cycad, synthesize the poison, and use it for their own defense, making them poisonous as well. They are brightly colored red with yellow strips to signal their toxicity.

Date palm: Produces dates, an energy-rich, nutritious fruit. They grow up to 30 meters high and live for 200 years. Date stone are ground and fed to animals. Their leaves are dried for weaving baskets and other goods, their sap can be made into a wine (lagmi), and after it stops producing fruit, its wood makes good timber.

Epiphytes: Plants that grow above ground using other plants or objects for support. They are not parasitic on their host trees, merely using them for height and better exposure to light. They do not have contact with the soil, so nutrients and water shortages are pressing concerns for these hangers on. Subsequently, they have many desert adaptations that collect and store water efficiently. Some epiphytes grow aerial root systems that intertwine and catch falling plant debris, absorbing the nutrients. Many have tightly rolled funnel-shaped leaves that direct water and debris to the plant base for absorption. These tanks of nutrients and water are also home for insects and small frogs. Some epiphyte tanks are so nutrient-filled that trees will grow roots into the epiphytes they host. Epiphytes are commonly found in rainforests, where moist conditions supply the needed water. Common epiphytes are bromeliads, orchids, ferns, mosses, lichen, and liverworts.

Giant Sequoia: Found on the western slopes of California's Sierra Nevada, these trees grow to 250+ feet and 100 feet around. Their fire-resistant bark accounts for their incredible longevity, some dating back 3,000 years.

Grass tree: A weed found in Australia's semi-arid deserts. This plant thrives on fire, relying on fire to stimulate new growth. Without fire, the vertical annual growth is less than 1 inch, but with proper burns, the grass tree is as tall as nine feet. After a bush fire, new shoots quickly replace the burnt top foliage, while the old leaves surround, protect, and bulk up the base of the trunk. They grow spikes 9 feet long packed with tiny flowers, and they sometimes produce multiple trunks. The height of the plant increases with more burns, and these plants naturally live at least 350 years.

Greater bladderwort: An aquatic plant found in swampy conditions. Camouflaged in its environment, this nine-foot long rootless plant feeds on insects, crustaceans, and larvae. It catches and digests its prey in translucent sacs that grow along the stalks of the plant. The sacs (5 mm across) have trapdoors and valves that maintain lower pressure inside the sacs. When prey triggers the trap, touching antennae around the trap door, the valve relaxes and sucks the creature in the sac. The trap door shuts, and the digestive juices start pumping.

Liana: Vines that seek support from other trees. They make up a significant portion of the vegetation in rainforests, climbing their way up to the canopy on the sides of other tall trees. Once they reach the canopy, they spread out from their host tree and compete for solar radiation. Lianas vary in size from small vines to thick woody stems up to 1.5 feet in diameter and over 3,000 feet in length. Unlike some parasites, lianas do not feed off their host trees, merely using them for architectural support.

Melon cactus: This new world cactus looks like a green bulbous melon with a thimble on top. The first years of growth are a fleshy, green stalk with spikes. It then grows a brown fuzzy cap that resembles a fez or a thimble. The brown cap, up to three feet tall, is covered with buds and small supple spines that turn into downy fleece. The green stem soaks up water to feed the cap, the buds flower and bear fruit at night, while the fleece protects the florets from dehydration.

Mycorrhizal fungi: Rainforest fungi that weave their threads around and inside the roots of canopy trees, drinking sugar and nitrogen from the trees. The trees in turn absorb the nutrients released by these detritivores.



Myrmecophytes: Rainforest trees that live symbiotically with colonies of ants. The tree provides food and shelter for the ants, and the ants defend the tree from leaf-eating predators.



Ophrys orchids: A genus of plants that mimic female bees and wasps to lure males into pollination. Though there are 30 different species, all ophrys have metallic-colored flowers that mimic the shape and color of a female insect's body, down to the furry texture. The flowers also release a smell secreted by the female insects. Once the male is on top of the flower, the orchid packs two pollen sacs on his back, fertilizing the next ophrys orchid that seduces him.

Parasol fungi: A fungi in the Amazon rainforest with tiny parasols 6 mm across. The Auka Indians make a paste from the fungi and spread it on a breastfeeding mother to cure her infant's diarrhoea.

Pebble plants: Plants in southern Africa that look like stones. They mimic the rock formation they call home in color, form, and texture. To tolerate arid climates, the pebble plants have two leaves fused into a sphere. They store sugar and water in their cells, able to survive drought for weeks. Every year new leaves sprout in between the old leaves and absorb their moisture. The old leaves fall, leaving scars beneath the new leaves at the base of the plant. You can count the scars to determine the age of the pebble plants, some dating 200 years old.



Phototoxic: Chemicals found in plants that are harmless by themselves but form a poisonous compound when exposed to light (due to a chemical reaction with ultraviolet light). Many plants in rainforests use phototoxicity to deter predation, though caterpillars have found a way around it. Caterpillars will feed on these plants at night and curl under the leaf during the daytime to protect them from ultraviolet light.

Podostemaceae: A family of aquatic herbs that thrives on the ledges of Iguazu Falls. They are short (less than four inches) flowering plants that resemble water lichen or mosses. They fix themselves to the rocks by means of a sucker. When the dry season lowers the water level, the plants immediately flower and release pollen to fertilize nearby plants. Their fruit ripens within a few days, drop on a nearby rock, and affix to the rock. When the water rises, the seeds germinate and produce new plants.



Prussic acid: A toxin that inhibits respiration. Certain plants of the rainforest produce a chemical that turns into prussic acid when its cells are disrupted by a predator's bite.

Puffball: A type of fungi that spreads reproductive spores on its own. When young, the puffball is soft but becomes increasingly brittle and delicate as it matures. Eventually it will become so fragile that any impact (even that of a rain drop) causes the outer casing to explode and release the dust-like spores into the air to colonize new ground.

Puya raimondii: A member of the pineapple family that grows in the Andes. It flowers once in its entire life and then dies. In the dry cold of the Andes, this bromeliad builds a trunk up to eight feet tall and 32 inches wide. Spiky leaves 47 inches long surround the trunk, as well as hook thorns along the border. Besides protecting the plant from herbivores, the leaves also insulate the trunk and prevent the sap from freezing. After 100 years, the plant reaches maturity and sprouts a floral crown that is 13 to 20 feet tall, consisting of several hundred branches curled tightly around the central spike. Such a crown carries up to 8,000 flowers. When the flowers wither, they release millions of seed, and the plant dies.



Rafflesia: This Southeast Asia rainforest plant is the largest flower in the world, up to 3 feet across and 24 pounds. It parasitizes the roots of lianas, and the flower is the only part of the plant above ground. Wrapped tightly

for most of the year, the rafflesia blooms for a few days with giant petals and a large bulbous center. Its coloring is mottled to imitate a carcass, and the rafflesia strongly smells of rotting meat to attract flies, its main pollinators.

Ricin: A protein highly toxic to humans, killing on a one to one ratio on a cellular level. This substance is found on the seed coat of the castor oil plant.

Rose of Jericho: A plant that wilts and shrivels in dry weather, but fills out and turns green again when there is water. Rose of Jericho is found in North Africa and parts of the Middle East.

Saguaro cactus: Shaped like a candelabra, this cactus grows up to 50 feet tall and 28 inches wide. This plant grows slowly, waiting up to 75 years before it sprouts its first offshoot. Though the shoots grow out horizontally, they quickly turn up and grow parallel to the main stem. These giants live centuries by obtaining water through a shallow root system radiating from the main stem, as far as 100 feet out. A deep root with lateral extensions anchors the tree to the ground. With this double root system, the cactus can store enough water to last a two-year drought. White blossoms open at night, and the saguaro cactus also produces a crimson fruit whose fermented pulp makes tequila.

Skunk cabbage: A plant that produces a poison that causes paralysis, sometimes death. It warns off would-be predators with its foul stench. Skunk cabbage sprouts early in the spring, producing its own heat. During the 12-14 days of flowering, the skunk cabbage produces enough heat to stay 36°F above the ambient temperature. It is not uncommon to find budding skunk cabbages on snow-covered ground with the snow melted around them.

Sundew: Small jewel-like plants that eat insects. They bloom into a radiant circle covered with oval glands that shimmer like nectar-covered lollipops. These glands are actually covered with sticky glue that trap insects, like a natural flypaper. Once the insect is trapped, the glands become tentacles, pulling the insect toward the center of the sundew, where the glands secrete acid and enzymes. After the insect is liquefied, the glands absorb the broth.

Stinkhorn: A fungi that sprouts from an egg-shaped fungal mass on the surface. It has unpleasant-smelling sticky residue on its tip to attract flies that disperse their spores. Flies eat this substance and their feet and bodies are covered with the tiny spores embedded in the goo.

Strangler fig: Found in rain forests, the strangler fig surrounds another tree and prevents its host tree from gaining sufficient nutrients. Birds deposit strangler fig's seeds onto the canopy, where they germinate in accumulated soil. Strangler figs drop roots along the host tree's side, quickly becoming a competitor for light and nutrients. They continue to drop roots until they completely surround the host tree. When the host tree dies, the strangler fig's roots constitute an outer trunk while the inside is hollow.

Tortora reed: A reed indigenous to Lake Titicaca. The native Indians harvest the plant and build reed boats for travel and fishing. The Uru live on floating islands made from tortora reeds. They build homes, churches, and even plant crops on the reed mats. Anchored to the shallow part of Lake Titicaca, the Uru add fresh layers of matted reed to replace the underside that rots in the water. The reed islands average two meters in depth.

Traveler's tree: A tree native to Madagascar with a palm trunk and a fan of leaves that spread out 180 degrees. These trees are designed for water collection. Ragged-edged leaves direct water down long stalks to a sheath by the trunk. These sheaths act as reservoirs for thirsty travelers. Since leaves fan out into a half moon, they catch every drop of water falling in their proximity. Traveler's trees are home to many creatures and watering stops for birds and humans (giving the tree its name). These trees flower ten inch long white



flowers and produce a blue fleshy fruit. Birds, who are fond of the tree's fruit, are the main dispersers of their seed.

Victoria amazonica: A giant lily pad with an upturned rim found in the Amazon basin. Spanning seven feet across, the lily pad has sharp spines on the underside of its pad, along the stem, and on the exterior of its budding white foot-wide flowers. This giant lily pad can hold a person's weight, and certain animals in the Amazon basin sleep on the lily pad.

Welwitschia plant: Found in the Namib Desert, this sprawling dwarf tree is no taller than a few feet but spans over five feet in diameter. It has long leathery leaves that tatter and stream in the arid wind. It's anchored by a woody root that grows over six feet long. When the desert fog rolls in, the plant absorbs moisture through pores on the leaves' surface and through its root system. The *welwitschia* waits for rain to release its seed and provides its seeds with enough food to last until the next rain, up to five years. These tough plants never grow more than 62 miles from the Atlantic Ocean and live a long time, the oldest dating back to the time of Christ.



Animals

Angwantibos: African rainforest lemurs with short, undeveloped tails. These small (usually less than a foot long) primates cling to trees with their hands and feet. Walking hand over hand along the trees and branches, the *angwantibo* feeds on insects and vegetation on the low shrub layer of the forest.

Army ants: Ranging from two to twenty millions ants, these large colonies eat everything in their path. Their strong hook-like jaws can quickly strip of carcass of its edible parts. Due to the size of their colonies, they often migrate and conduct raids, marching in columns 50,000 strong. American Indians used the army ant to stitch wounds, forcing the ant to bite either side of a cut. Once the skin was closed, its body was removed, leaving only the jaws.

Aye-ayes: Found in Madagascar's rain forest, the *aye-aye* is the smallest of the lemurs (max. body length of 17.5 inches, max. tail length of 24 inches). It is a night feeder, consuming insect larvae, eggs, shoots, and fruit. Each hand has an exceptionally long middle finger used to tap on trees and capture wood-boring insects inside the trees.

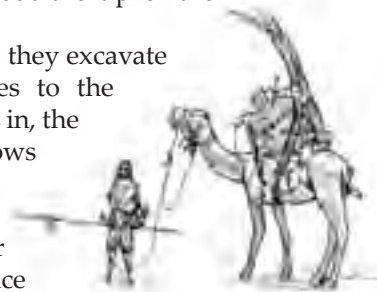
Bleached earless lizards: The typical brown earless lizard of New Mexico has a pale relative living in the White Sands Desert. Curious and fast runners, these lizards shed their tails if seized and grow new ones.

Blister beetles: Insects whose larvae practice collective mimicry. Larvae group together, forming the shape of a female bee. When they attract a male bee, as many larvae as possible cling to the male bee's chest. When the male bee does find a female bee, the larva let go and feed off the female bee's eggs.

Bombardier beetles: Insects that spray corrosive substances from the end of their abdomen. These beetles store chemicals in a chamber in their abdomen with a muscle-controlled valve. When threatened, the bombardier beetle mixes the chemicals and brings them to a boil. The subsequent gases close the valve and shoot the boiling liquid out the tip of the abdomen with a loud pop.

Button beetles: Found in the Namib Desert, they excavate parallel furrows in the sand at right angles to the direction of the wind. When the desert fog rolls in, the moisture is captured on the ridges of the furrows and anxiously devoured by the beetles.

Camels: Highly adapted to desert environments. They can lose up to 1/3 of their weight before it becomes harmful. They reduce their loss of water by excreting concentrated urine and



nearly dry feces. Course hair protects them from solar radiation and whipping sands. Long bushy eyelashes and thick lids protect their eyes from sand, while closing their nostrils at will prevent them from breathing in sand. They tolerate greater levels of dehydration before it becomes debilitating, and they recoup their liquid loss quickly when they do have access to water.

Clown anemone fish: Fish found in coral reefs that hide from predators inside large sea anemones. Their body secretes a mucus which protects them from the anemones' poison.

Cormorant: Birds that dive for their prey and stay under water up to 30 seconds. They wait to consume their food until they resurface, shaking their catch before they swallow. Fishermen have domesticated the cormorant along the River Xi in China. They fit a tight collar around the cormorant's neck preventing the bird from swallowing any but the smallest prey. When the bird dives for fish and resurfaces, the fisherman collects the catch.

Cowfish: A fish that took a different evolutionary path. They have an exterior of fused plates, forming a carapace around the fish. Typically box-shaped with a triangular cross-section, their slight horns give the cowfish its bovine-inspired name. Most abundant in tropical waters, cowfish are brightly colored and appear to hover through the water due to their unique physiology. Unlike other fish, they use their fins for rotary motion and use their tail as a rudder. They also inflate themselves as a means of defense (like pufferfish), and release an ostracitoxin against predators. Using a similar blowing mechanism, cowfish blow jets of water into the sand with their mouths, uncovering their meals of crabs and shrimps. Some cowfish grow as large as 20 inches, though those kept in captivity are often no larger than 12 inches.

Cuttlefish: Predacious carnivorous cephalopods (head foot). Related to squids and octopi, the cuttlefish is actually a mollusk, phylum of snails, clams, and slugs. Like other cephalopods, they change their coloring and move very fast in the water. Beneath the cuttlefish's mantle is a cavity lined with muscles. Through contracting and relaxing these muscles, the cuttlefish controls how much water is in the cavity and allows it to float motionless in the water. The cuttlefish takes off by shooting water out of its cavity through a muscle funnel (whose width it can also control).

Damselflies: These relatives of the dragonfly have four independently beating wings, giving them ultimate control of their flight. In rainforests, giant damselflies hunt for webs of orb-weaving spiders, mesmerizing them with their wings. The giant damselfly then snatches the spider, snaps its thorax and eats the remaining juicy abdomen for dinner.

Elephant birds: Standing 10 feet tall and weighing 1,000 pounds, the elephant bird is a foraging vegetarian due its inability to fly or run fast. Its egg weighs 20 pounds, measures 14 inches in length, and has a capacity of two gallons. Once found in Madagascar, this giant bird is now extinct.

Emperor penguins: These flightless birds return to ice shelves in winter when all other creatures have left. They gather under the cliffs by the thousands, identifying their mate by each bird's unique song. Without any materials for nesting, male birds carry the egg laid by the female. They position the egg on their feet and settle their warm belly over the egg until it hatches.

Extremophiles: Microbes that survive extreme conditions: heat, acidity, salinity, pressure, cold, and other environmental constraints deadly to more familiar life. After *Streptococcus mitis* went to the moon and made it back alive, scientists had speculated panspermia-the seeding of microbial life from one planet to another. Some studied microbes resumed metabolic



activity after being frozen for thousands of years. "The planets are always swapping spit." ~Chris McKay, astrobiologist at NASA's Ames Research Center.

Flag bugs: Rainforest insects that suck the sap of the poisonous passion flower. It stores the toxins and uses it for its own defense. To flag its toxicity, its body and wide flag-like legs take on vibrant colors. If predators still attack, the flag bug waves its leg to distract the predator away from the body. This apparently works since flag bugs are frequently found with one or both of their legs missing.

Flamingos: Tall birds with skinny legs, often revered in the form of lawn ornaments in Florida. They are pink (sometime crimson and vermilion) because their diet is high in alpha and beta-carotene, either through brine shrimps or blue-green algae, which turns red after it dies. They prefer shallow waters to feeding and nesting. While adults eat diatoms, seeds, blue-green algae, crustaceans, and mollusks, their young eat "crop milk," a dark red secretion high in fat and protein from the upper digestive tract of male and female flamingos. Although flamingos drink fresh water, flamingo colonies are often found in the high-saline lakes of Africa, where they can nest with little competition from other animals.

Flying snakes: Arboreal snakes that live in the rain forests of South and Southeast Asia. These snakes glide from tree to tree by jumping from a tree and flattening their bodies into parachutes or gliders. They ride the air currents to the next tree or safely onto the ground. They are typically 3-4 feet in length and can cover 300 feet (100 meters) in one glide.

Giant Clams: The largest type of clam, some longer than 4 feet. Though fabled man-eaters, giant clams are filter eaters, receiving nutrients from the algae living in its tissue. Giant clams also receive their vibrant colors from the algae. Giant clams are found in shallow waters, and once they begin to grow, they stay in the same place for life. They also move very slow, taking several minutes to close their shells.

Giant Pangolins: A large ant and termite eater covered in scales. This African forest native, growing up to 4.5 feet long and 75 pounds, can eat up to 200,000 ants a night. They are nocturnal animals that burrow homes up to 120 feet long and 15 feet underground. With the aid of their tails, they can walk bipedally, and when they walk on all fours, they curl their front feet under to protect their claws. This would be the human equivalent of walking on your wrists. When they are startled, they tuck their head between their front feet, using their strong shoulders as armor. If touched, they curl in a ball. The scales on their tail are sharp and can be used as weapons.

Gemsboks: In the Kalahari these antelope cool their hot blood to normal body temperature by circulating it in extensive capillary networks in the nose before it enters the brain.

Glass frogs: Arboreal frogs found in rainforests. They are usually varying shades of green that are partially translucent. Their internal organs are visible where they have translucent skin, typically around their stomachs. They lay their eggs, which are also translucent, on leaves while the male frogs stand guard.

Golden bamboo lemur: Endemic of Madagascar, this lemur feeds on young bamboo shoots despite the high levels of cyanide in the plant. The golden bamboo lemur can tolerate otherwise toxic levels of cyanide. Though specialized in his feeding habits, this primate does not have much competition for bamboo, lethal to most other animals.

Golomyanka: A deep-water fish found in Lake Baikal. Eight inches long, scaleless, and completely transparent, this fish lives in depths of 1,650 feet. A third of its body weight is oil. It comes to the surface at night, feeding on



zooplankton. It must descend before the water heats to 45°F (7°C), or else the oils in its body liquefy, resulting in death. Unlike most fish, female golomyanka do not lay eggs, but give birth to live larvae—an event they rarely survive.

Headstander beetles: Found in the Namib Desert, they perch on top of the dunes upside down with their backs to the wind and their heads between their legs. In this position the desert fog condenses on their carapaces and trickles into their mouth.

Hippos: Large, moody wetland creatures. These streamlined giants weigh in at 2+tons, grow to 15 feet long, and are capable of holding their breath for 5 minutes. Built to lounge in the water, their eyes, nostrils, and ears are above water while the remainder is below water. Hippos also hear through air and water at the same time. Called infrasound, this dual hearing allows hippos to communicate long distances regardless if they are underwater. It is speculated that they “hear” in the water through the large blob of blubber under their jaw, similar to how dolphins use their fatty forehead to channel sound. Though they are herbivores, hippos are notoriously bad tempered and will attack other large animals. For a smaller brand of hippos, consider the pygmy hippos of West Africa that are only 40 inches tall and 500 pounds each.

Huankela: A giant frog found at the bottom of Lake Titicaca. The frog grows up to two feet long and breaths through his skin, rarely coming up to the surface for air.

Katydid: Insects that specialize in subterfuge. These cricket relatives take on the shape and color of leaves found in their native habitat or the appearance of other insects. When camouflage fails, they have a second pair of differently colored wings that they flash. These startle wings are typically bright colors and have eyespots to divert the attack from vital spots. They are especially abundant in the Amazon rainforest.

Lar Gibbons: The smallest of apes that live primarily in Asian rainforests. Also called white-handed gibbon, these primates have long arms that swing them from tree to tree, strides up to 50 feet long at 35 mph.

Leaf-cutter ants: Ants that take vegetation back to their underground nests and finely shred them. Worker ants process the shredded leaves and sow them with fungi spores, farming the fungi gardens that feed the ants. One Costa Rican tree (hymenaea courbaril) has produced a fungicide in its leaves to deter these ants.

Magnificent bower birds: A bird whose male member is resplendent in color. Unfortunately, this bird lives on the rainforest floor where little of the sun’s light penetrates the canopy. This bird systematically defoliates patches of canopy far above, choreographing shafts of light that will penetrate his bower and illuminate his iridescent coloring, attracting a mate in the process.

Marsupial frogs: Frogs that carry their eggs in a sac, located on the female’s back. The female lays the eggs, the male fertilizes them and places them into the female’s sac. After four weeks, the eggs hatch and up to thirty froglets emerge from the sac. Female pygmy marsupial frogs carry their fertilized eggs in a sac under the skin, giving the appearance of boils across the back. When the eggs hatch, frogs emerged from busted boils.

Mudskippers: Fish that survive in water and on land. Commonly found in mangrove swamps, mudskippers spend most of their time on land and actually move faster on land than in water. So adjusted to brackish water, the mudskipper dies if placed in saltwater or freshwater. Though they have gills for breathing underwater, they also have mechanics for extracting oxygen on land. They carry water in their expandable gill chambers or in their mouths, allowing them to walk on land and still extract oxygen from



water. They can also extract oxygen from their wet skin, easy replenished by rolling in a puddle every few minutes. They walk with a front pair of fins that act like arms (complete with elbows) while a secondary pair of fins in the back act like suckers, allowing the mudskipper to cling to wet surfaces. Its eyeballs protrude, not unlike periscopes, and move independently of each other. During mating season, the males take on more color and perform courtship displays, such as erecting their dorsal fins, doing push-ups or spectacular flips out of the mud, and flaring their dorsal fin at the top of the leap.

Nerpa seals: One of the world's two freshwater species of seal. Found in Lake Baikal, they breed on the frozen lake in winter and give birth in snow lairs from late February to early April. In winter they make air holes in the ice and maintain them by gnawing from below, making life above and below the frozen lake possible.

Nudibranchs: Shell-less mollusks commonly called "sea slugs." Sometimes mistaken for worms, nudibranchs have brilliant colors, possibly to warn of the noxious chemicals (including sulfuric acid) it secretes for would-be predators. Some nudibranchs feed on creatures with stinging cells, separate the stinging cells from their prey while its inside their digestive system, and move said stinging cells into their own skin for protection. Found in reefs, these hermaphroditic creatures range in size, from as small as a fingernail to human size.

Rain frogs: Frogs that live their lives on land. Common to Central and South American rainforests, these frogs lay their eggs on leaves and moss, hatching tiny froglets six millimeters long. These frogs come to maturity on land instead of in water. This is only possible in water environments where they do not dry out.

Sharp-beaked ground finches: A bird found in the Galápagos Islands that drinks blood. It pecks at seabird's wings and tails and drink their blood.

Shield bugs: Type of insect found in Australian rainforests. Brightly colored and iridescent, these insects use color to flag toxicity or unpleasant taste to predators, though most are harmless. They also group together, intensifying their color signal and deterring predators. Tasty, nontoxic insects would not gather together so boldly, would they?

Susu dolphins: The fresh water dolphins found in the Ganges and Indus River. They are blind and use echolocation and their sensitive front flipper to find food in the murky waters.

Swallowtail butterflies: The larva of these rainforest inhabitants imitates bird droppings, effectively camouflaging them from birds and other predators.

Tapirs: These pig-looking animals actually belong to the odd-toed hooved animal family (perissodactyls) like horses and rhinos. Three of the four species reside in Central and South America, with the fourth living in Southeast Asia. Their weight varies from 300 to 800 pounds, depending on species. They gravitate toward wet climates and usually live near water. Voracious vegetarians, they often have problems with local farmers.

Tardigrades: Microscopic animals that resemble teddy bears: little legs bowed outward, a full tubular body, tiny eyes and structures around its head. As small as a tenth of a millimeter, tardigrades have changed little in over 65 million years. They are multicelled creatures with rudimentary blood and immune systems and a brain. They live in hot springs, frozen tundra, and deserts, feeding off algae through a sucker mouth. Tardigrades have evolved to tolerate repeated freezing by creating its own antifreeze and encouraging the growth of ice crystals on a cellular level, preventing its cells from rupturing as human cells do. Frozen tardigrades achieve cryptobiosis and come back to life after thawing.



Tent bats: Tiny fruit-eating bats found in rainforests. Two inches long, these small bats eat the midrib of a large leaf, causing the sides of the leaf to droop. Tent bats make these leaf tents for shelter, typically in groups of 15-20 bats. In these groups, there is only one male, the rest comprising his harem.

Tree ants: Australian rainforest insects that make their nests from leaves. They sew the leaves together with a sticky silk substance extruded from their queen's larva, gently squeezed like a tube of toothpaste. Their relatives in Central Africa and South East Asia are called "weaving ants."

Three-toed sloth: Frequenters of Central and South American rainforests, the three-toed sloth spends most of its time sleeping, hanging in the trees (up to 19 hours a day). It has no external ears or tail and hangs on to the trees with its long hollow claws, of which the middle claw is the largest. It descends to the forest floor to urinate and defecate once a week. Its coat of long coarse hair is home to beetles, moths, and colonies of algae, which tint its fur green. When the sloth descends to the forest floor, beetles lay their eggs in the sloth's excrement and hop back on their sloth. When they eggs hatch, the insects fly into the canopy and find their own sloth-based microclimate.

Thorn bugs: Insects with a disguising carapace shaped like a thorn. Besides providing camouflage from predators, rainforest thorn bugs are brightly colored to alert predators to their impalpability.

Troglobites: Animals restricted to cave life due to adaptations. These specialists typically lost functional eyes, coloration, and the ability to cope with variable temperature and moisture conditions. They rely on other senses, which develop with hypersensitivity to compensate for lack of sight. Typical examples are beetles, spiders, millipedes, mites, fish, crayfish, shrimp, and flatworms.

Woodpecker finches: Birds on the Galápagos Islands that uses tools to extract insects. In absence of woodpeckers on the Galápagos, woodpecker finches hold cactus spines or twigs in their mouth and probe cracks and crevices for food. Sometimes they spear a grub, other times they disturbs the insects, forcing them out. When insects surface, the finch drops the tool and snatches his meal. They are so crafty that finches will shape a twig if an appropriately sized one it not available.

Magiovores

Animals

Angler Lizard: Angler lizards are similar in appearance to geckos, but larger. Not including the long semi-prehensile tail, the largest angler lizards are around three feet long, but the average size is around 1.5 feet. These lizards have long, barbed tongues that magically glow at the tip. They also have wide-toed feet (they're arboreal during the day) and can magically walk on water. At night, the angler lizards descend from the trees and spread out over the shallow parts of lakes and ponds. They flick their tongues out over the water like fireflies and eat what fish come to the surface. Occasionally an angler lizard catches something too big and loses part of its tongue, but it will quickly regenerate. Angler lizards are magically dependent animals that require magic, air, water, and food to survive. They are only found along wooded waterways or lakes and only in temperate and tropical areas.

Bone Render: Looking little different than a regular shrew, bone renders possess magically powerful jaws and an enhanced digestive system. Once the larger scavengers have their way on vertebrate carcasses, bone renders rise up from their holes (much like prairie dogs' holes, but smaller) and start eating away at the bone itself. This process is a very noisy one,



and forever remembered once heard. Bone renders have a truly noxious scent they spray for self defense which is on par with skunk scent. Bone renders are magically dependent animals that need magic, bones, air, and water to survive. They are found mostly on grasslands and scrublands.

Bountiful Deer: Bountiful Deer (also known as deer of plenty) travel in small herds (6-10) and usually avoid settled areas. These speckled deer radiate a constant plant growth effect where they roam and tend to have a territory of several hundred square miles. During their migrations, most of the land in the area is under a plant growth enrichment effect for only a few days, but mating grounds benefit the most (almost a full month). Deer of plenty use the overgrowth aspect of plant growth to avoid predators, and they have so far eluded domestication. Any captured deer of plenty usually dies of a mixture of fright and dehydration within 1d6 days. Bountiful deer are not magically dependent animals (although their plant growth won't work without magic) that need grass, air, and water to survive. They can be found anywhere regular deer are found. A knowledge (nature) DC 20 check is required to identify a bountiful deer and a knowledge (nature) DC 25 check is required to identify the mile radius area effect of a bountiful deer mating ground.

Cavern Ooze: The cavern ooze is a tiny ooze posing no threat to anything larger than itself. Cavern oozes have two types of secretions, a mild paralytic and an acidic. It uses these two secretions to capture its prey, bats. A cavern ooze holds onto the ceilings of caverns, lying in wait for a bat to land nearby. It then slides up to its prey and uses its paralytic ooze to capture it. Once captured it devours the bat in a few hours. During the night, cavern oozes leave their caves and circle round the nearby fruit trees while secreting a light acid. This acid kills the surface plants, and leaves behind a layer of microscopic detrital feeders who start to decompose the dead plant material. In effect, the ooze helps fertilize the fruit plants, ensuring the survival of its prey. Cavern oozes are magically dependent animals that require magic, air, water, and food to survive. They are only found in or near caverns containing bats.

False Grass: The bane of herders and ranchers, false grass is a vicious, predatory worm that cryptically disguises itself as normal grass. The helpless grazer bites through the false grass, swallowing it with the rest of the true grass. In the creature's digestive system, the predator takes hold, quickly reproducing and slowly starving the host creature to death by interfering with food absorption. Once the creature dies, the worms eat the animal from the inside out in a gluttonous and reproductive frenzy. Occasionally false grass expands to catastrophic levels, destroying entire herds in a period of months and leaving the creatures that depend on those herds without food. If a carnivore or omnivore consumes a piece of meat from an infected herbivore, a fortitude check (DC 10) is required to avoid infestation. An infested carnivore only suffers a -2 to all actions because of nausea for three days until the false grass is naturally destroyed by their body's defenses. False grass is a magically dependent animal that needs air, water, magic, and food to survive. False grass is most common on grasslands, but some are found on the tundra.

Flying Gulper: Flying gulpers are small constricting feathered snakes native to tropical rainforests that use magic to fly. They're mostly arboreal and nocturnal, hunting at night for birds, snakes, insects, and basically anything else that fits inside its mouth. Flying gulpers occasionally venture out to sea, gulping small surface fish. Flying gulpers are magically dependent animals that need magic, air, water, and food to survive. They are only found in tropical rainforests.

Fright Owl: At first glance, a fright owl looks similar to many species of wood owl. Like most owls, they are stealthy predators, but they have



developed a unique method to flush out their prey. Again, like most predators, the fright owl's vision easily picks up movement, but prey who have frozen in place or sought cover are hard to discern. The fright owl uses its terrifying hoot as its main hunting mechanism. Any creature failing a will save (DC 14) suffers the effect of a cause fear spell. Fright owls are magically dependent animals (they cannot hunt successfully enough without using their hoot- they eventually suffer a slow death of starvation) that need magic, air, water and food to survive. They are common in any forest, but some fright owls are similar to ground owls and are found on the plains.

Ore Rats: These shiny black rats have adapted to life underground. Using magic, they digest metallic minerals to sustain themselves. A single ore rat needs less than ¼ oz. of worked metal or 1 oz. of a metal ore to survive for a few days. Ore rats can move slowly through earth like Xorn (some scholars put forth the idea that ore rats were originally from the elemental plane of earth) at a speed of 10 feet a minute. An ore rat infestation is the bane of a good mine, but the presence of ore rats on a mountain may lead the stealthy (or wilderness wise) to a new source of minerals. Ore rats are magically dependent animals that need magic, metallic minerals, and water to survive. They need only drink once a month and are only found underground or on the surface in very rocky terrain.

Shade Slug: Preferring darkness, these three inch long, dark-hued slugs dwell in virtual seclusion beneath rocks, homes, and dense shrubs. Few pay the slimy creature any attention, but ingesting the live, foul-tasting, mollusk bestows low-light vision for two hours. Successfully ingesting the slug requires a will save (DC 10) and a fortitude save (DC 10); otherwise the ingester spits it out or vomits. Correctly identifying the shade slug requires a knowledge (nature) check of DC 15. Shade slugs are not magically dependent mollusks (but without magic they grant no low-light vision) that require air, water, and food to survive. They are found only in tropical and temperate forests.

Fungi

Bloodmat: This dark red fungus lives in low areas prone to collecting blood, such as carnivorous lairs, slaughterhouses, or torture chambers. It is harmless until reaching the fruiting stage. At this point (about a year in most situations) a flat and thick mushroom grows (called a "mad steak"). Looking like a spongy, bloody brick, it is often eaten by carnivores. This usually drives them mad with terrible hallucinations, and the creature feels an overwhelming urge to flee that lasts for three days. Most creatures run until their heart fails or they drop from exhaustion or dehydration. The fungus then takes hold in the creature's body and put out its reproductive spore bodies. These edible red mushrooms then release their spores into the air within a week. Bloodmat is a magically dependent fungus that needs magic, blood, water, and air to survive. It is found anywhere its requirements are met. Bloodmat poison: Ingested, DC 24, Initial effect; Panicked and hallucinatory, Secondary effect; Panicked and hallucinatory; Duration of effect; 3 days.

Death's Bloom: This large, brilliantly colored mushroom is found only on the heads of dead bodies. If ingested they cause temporary madness and euphoria. However, they also grant 1d6 random memories from the deceased. Some may be useful, such as the exact process for casting a spell or the command word for a magic item, while others will be less useful, such as visions of cleaning a table or of stargazing. Death's Bloom is a magically dependent fungus that needs magic, air, water, and a host to survive. The poison in a Death's Bloom requires a fortitude save (DC 15) and causes initial and secondary damage of 1d6 temporary Wisdom ability damage. The



inger is also afflicted with acute paranoia (treat his attitude as unfriendly) for a period of 1d6 hours.

Lifegiver: This yellow fungus is most commonly no larger than a dwarf's forearm, but whole caverns can be coated in a single continuous carpet of lifegiver if moisture levels are high. It fruits twice a year, and its fruits fill with mostly oxygen and some helium. These soft purple puffballs then float up to the top of the cave, remaining until their outer layer decomposes or is punctured by protruding stone. When this happens the puffballs release their spores into the air. Lifegiver fungus continually expels breathable air throughout the year, a great benefit for all underground creatures. Enough lifegiver fungus in a single cavern can create underground air currents upon which their spores can reach new places. Given enough time, this fungus can create caves as they slowly eat away at the surrounding stone, which it uses as food. Lifegiver is a magically dependent fungus that needs stone and magic, to survive. It is mostly found underground and, although it doesn't need water to survive, is more successful in moist conditions.

Somnolent Moss: This purple moss thrives in dry areas and uses water as its primary food. It only grows in extremely dry areas (too much water kills it instantly) and it emits a sweet smell to a range of 10ft. that has the same effect as a very powerful sleep spell (fortitude save DC 12) that lasts for a week. The moss eventually covers a victim that falls asleep in a period of days. A creature gets a single additional saving throw after two days, but if that is failed, the fate of the creature is sealed as the moss drains the water from the creature, leaving a perfectly desiccated corpse. Mummies and other intelligent desert dwelling undead favor somnolent moss and often place patches of it throughout their lairs. Somnolent moss is a magical dependent fungus that needs magic, air, and water to survive. Somnolent moss is only found in deserts.

Gems

Crystal Grazer: The crystal grazers are a family of many colored crystal lattices through which air travels. This living crystal filters the underdeep air of microscopic magiovores, much like ocean sponges filter the ocean's water for its food. Crystal grazers inhale carbon dioxide, store it in small hollow structures within their crystal latticework, and use the carbon dioxide in their digestive process. The multi-colored crystal grazers are often found clinging to underground areas frequented by living creatures that profit greatly from their air purification side effect. Intelligent races often create caves containing lifegiver moss and crystal grazers throughout their strongholds. Identifying a crystal grazer requires a knowledge (dungeoneering) check DC 10. Crystal grazers are magically dependent gems that require magic, carbon dioxide, and food to survive. They are only found underground or in caves. Sunlight eventually breaks down their crystalline structure, killing them.

Long Hauls: Long hauls are small crystalline life forms found in the underdeep. They're shiny and look like a mixture of mica and dry seaweed. In desperate situations, carbon-based life can eat long hauls and find enough sustenance to survive. A single long haul provides three days' worth of sustenance for a medium-sized creature. The sustenance is slowly released over the three-day period, but hunger is not assuaged even though all needs are being met. Long hauls taste awful and are usually found in small groups of three or four. If consumed for more than ten days, long hauls act like poison (Ingested, DC 15, Initial effect; 1 Con, Secondary effect; 1d8 Con) and do not provide nourishment. Identifying a long haul requires a knowledge (dungeoneering) check DC 10. Long hauls are magically dependent gems requiring magic and stone to survive. They are only found underground.



Insects

Assassin Caterpillar: The innocuous orange-spot butterfly has a very dangerous beginning. The larval stage is a large caterpillar (about 6 inches long) with many hard spines that act like hypodermic needles. These spines inject a powerful hemotoxin into a victim. A DC 15 fortitude save is required to avoid the initial permanent damage of 1 constitution point. The secondary save is DC 15 as well and if failed, 2 hit points per hour are lost. This usually results in the quick death of the hapless victim whose body blackens around the puncture site from the breakdown of his arteries and veins. A neutralize poison or heal stops the damage, but regular healing via healing magic can postpone the inevitable if these two methods are not available. Assassin Caterpillars are magically dependent insects (the orange-spot butterfly is a pure magiovore) that need magic, air, water, and preferably the leaves of a fruit plant (grapes, apples, pears, cherries, etc.) to survive. Only the toughest of leather prevents the poison injection, but any metal does the trick.

Bookworm: The bookworm is a tiny, 1-inch long, gray, seemingly normal worm. It is the bane of scholars, wizards and sages, for its primary source of food is the paper, wood, and leather that make up books. Bookworms cannot harm living creatures but they burrow through wood, leather, rope, and paper very quickly. They ignore the hardness of such materials and deal a point of damage per hour to such materials. Bookworms are magically quick and agile (moving at 20ft. per round) and seek to avoid being seen. They can alter their coloration (DC 20 to see a camouflaged bookworm) to protect themselves from predators. Since bookworms are particularly fond of magical books and scrolls, it's speculated that bookworms are a strange form of magically altered grub. But originations aside, a bookworm can destroy one spell level per hour through its burrowing. After eating a full ten levels of spells, a bookworm makes its escape to form a chrysalis at some safe place. Within two months, a spell moth is born. Bookworms are magically dependent insects that require magic, water, air, and food to survive. They are most common in temperate or tropical civilized areas, but they are very rare even there.



Bowel Beetles: The dark brown dung beetles have adapted a magical way to ensure their food supply. Whenever a medium size or larger creature comes within 5 ft. of the bowel beetle, it may release a magic pheromone that induces the creature to evacuate its bowels. A fortitude save (DC 12) avoids this effect, but a failure results in the victim having 1 minute to prepare for the inevitable. Bowel beetles are often used in juvenile pranks, but some pranksters find themselves as much a victim as their intended. Bowel beetles are magically dependant insects (the pheromone release induces the search for food, without the release the beetle never searches for food beyond immediate sensory range) that need magic, air, water, and food to survive. They are most common on grasslands, but can be found in any temperate or tropical environment.

Clikkit: Relatives of the common cricket, clikkits differ from their more prevelant cousin in one notable way: they are sensitive to magical energy. Clikkits only chirp when within 30 ft. of a magical aura (such as a spell or magic item). Although similar to a regular crickets chirp, the clikkits chirp is more stacatto, requiring a listen check (DC 25), survival check (DC 20), or knowledge (nature) (DC



20) to tell the difference. If an hour or more is spent under tutelage listening to tell the difference, the DC's lower 5 points to 20, 15, and 15 respectively. Intelligent forest species have been known to use klikkites as sentries. Klikkites are not magically dependent creatures (but magic is required for them to detect magic auras) that require water, air, and food to survive. They are found mostly in temperate and warm forests, but there is a species that live underground; the cave klikkit.

Cruel Guest: The cruel guest is a parasite much like a mite or a bedbug and is found in similar circumstances. Once infected a creature loses 1 point of constitution per day while suffering a cumulative -1 penalty to attack rolls, skill checks, and saving throws from the pain of the burrowing parasites. When reduced to 0 Con, the host dies. A cure disease spell or drinking a quart of dragon blood kills the creature. Cruel Guests are magically dependent insects that need magic, water, a warmish environment (beds, piles of leaves, nests), air, and a host creature to survive. They are common in civilized areas, although they usually appear more like a plague than an everyday occurrence.

Double Bug: The double bug is a brown beetle with a single horn. It spends most of its time on fallen trees, eating furrows into the wood. It has a very unique defense mechanism. When any creature of diminutive or larger size comes within five feet of the double bug, it makes a mirror image of itself to distract any potential predators. It can only create one image, but that is often enough. Double bugs are magically dependent insects that need magic, wood, water, and air to survive. They are common in boreal forests, and less so in deciduous forests.

Spell Moth: This gray, normal looking moth is much sought after by spell casters. It is the adult form of the bookworm and when eaten, it conveys a spell into the eater's memory. This has various effects depending upon the eater. First, either the intelligence, wisdom, or charisma of the eater must be 10 or greater; if this is not the case, nothing happens upon consumption. If one of these statistics is above 10, the highest statistic is used to determine what spell has been gained (if the statistics are the same, the class preference is used first and if that is still insufficient, random determination results). After all of this is determined, a single 1st-level spell is gained as a spell-like ability (Su) useable once per week. If based upon wisdom, it will be from the druidic list; if based upon intelligence it will be from the sorcerer/wizard list; and if from charisma it will be based upon the bard list. A creature can only have three spells gained from spell moth consumption. If more are consumed, it acts as a tremendously lethal magical poison (fortitude save DC 35 or die) and does not result in any increase in gained spells. Spell moths do not detect as magic and require a knowledge (nature) check of DC 30 to properly identify. A spell moth is a magically dependent insect that requires magic, water, air, and food to survive. They are extremely rare and usually found in temperate or tropical civilized areas.

Stonemite: The stonemite may be considered the underdeep equivalent of the termite. Living on stone (opposed to wood), stonemites often make their nests in stalactites, stalagmites, or columns. Within these formations, the colony expands over a period of many years (sometimes hundreds) until a new pair slides through stone to find another suitable cavern system. Stonemites eat a mixture of stone dusts, crystals, and fungi, which they grow inside their nests in special chambers. To ensure survival of the a new colony, mating pairs roll in the spores of the colony's food caves so that when they find an appropriate cave, livegiver fungus, crystal grazers, and long hauls invade the cave to create a more stonemite-friendly environment. Stonemites are a very important function is the growth of livable caverns throughout the underdark. They have several different castes: workers, soldiers, digesters



(who turn stone dust into a syrupy liquid that humanoids can eat, but which tastes disgusting), water-makers (who use magic to create minisule amounts of water), and the queen. Stonemite colonies can have up to several million members and can eat 5 sq. ft. of stone in a year's time. Stonemites are magically dependent creatures that need water, air (very little in comparisons to non-magical insects), and stone to survive. They are only found underground.

Terror Wasps: The bright red terror wasps evolved more than a mild protective sting for hive defense. When any creature of small or larger size comes within 20ft. of a terror wasp nest, the nest swarms and attacks. Its victims are usually quickly frightened away as the wasps terror attack (DC 18 or become panicked) takes hold, and those that aren't are still subject to their sting attacks. Terror wasps are considered a delicacy by many tropical races and are the favored food treat for shambling mounds. Terror wasps are magically dependent insects that need magic, fruit, air, and water to survive. They are found mostly in tropical rain forests, but seem to be moving into deciduous forests.

Plants

Bamboo: This magical, high-quality bamboo is treasured by many cultures. If allowed to grow to full size, it achieves an impressive width and girth. Any object made from bamboo is treated as a natural masterwork item. The only disadvantage of bamboo is that the growing plant is a voracious magiovore. If a stand of more than five bamboo plants occurs within a 10ft. area, that area is effectively a null magic zone. Bamboo can out compete regular bamboo, but it often kills itself off through its magical greediness. Some cultures carefully tend to their bamboo, using it as defensive measures in permanent defensive structures. Bamboo is a magically dependent plant that needs magic, air, water, soil, and sunlight to survive. Bamboo is a tropical plant that grows anywhere bamboo can be found.

Elysium Grass: This yellow grass looks like many other savanna flora, growing as high as three or four feet with wide, sharp-edged blades and fluffy seedpods. It is an aggressive grower and tends to choke out other plants. The elysium plant is a magic sponge, soaking up all the nutrients in the ground to reduce competition and relying mostly on magic. It soon overbalances the ambient magic and creates a null-magic zone around itself in which no spell, spell-like ability, or supernatural ability will function. Elysium plants take hold quickly and can rapidly destroy the fertility of an area, but they are usually kept in check by self-selection; the majority of elysim plants end up starving themselves to death within five years. This leaves a wake of poor soil behind the plants that is soon subject to normal succession. Elysium grass is a magically dependent grass that needs magic, water, air, and soil (however poor) to survive. It is mostly found on dryer grasslands, but it is sometimes found underground if soil is available.

Houseplant: A rare, magical version of the baobab tree, the houseplant is alike in all ways (DC 27 knowledge (nature) to identify) except when hallowed out and used as a home by an intelligent spellcaster. When occupied by a spellcaster, the houseplant drains a 1st-level spell (DC 20 will save to resist) and casts a hallow spell (or unhallow if spellcaster is evil) with a zone of truth associated spell effect using the drained magical energy. The draining occurs every morning or every midnight (if evil). It is uncertain how or why the houseplant acts in such a manner, but scholars think there must be some selective advantage in its behavior. A few scholars postulate that the plant may be deliberately using intelligent species for propagation, but it is



not a widely held view. The houseplant is a magically dependent plant that needs magic, water, soil, air, and sunlight to survive. It is rare and found only in terrains occupied by its non-magical cousin, the baobab.

Lumin: This small insectivorous, flowering plant remains dormant during the day. At night it opens up, releasing its anemone-like flowers that glow with a soft magical light. This light is very attractive to insects that the plant traps and eats. Lumins are epiphytes, decorating the trees of the forest in an eerie green-yellow light. Lumins are magically dependent plants that require magic, water, air, and food to survive. They are most common in tropical forests, but are also found in warmer temperate forests.

Spriggan Tree: The spriggan tree (also known as the lung tree) is the largest plant in most fantasy worlds. Growing to a truly gargantuan 800 feet tall with a base circumference of more than 300 feet, the spriggan tree gets its name from its unusual growth cycle. For half of its long life (over 350 years) it grows up and for the remaining half it shrinks. At mid-growth, when the tree is at its tallest, it is often used as a nest by large flying predators. The tree's acorns are jug sized and edible although not very tasty and you had best hope it doesn't land on your head when it falls. A single mid-growth spriggan tree can provide weeks worth of work for lumbermen and on the rare occasions when a mid-growth tree falls, a large swath of the forest is taken with it, creating a bounty for successional activity. Spriggan Trees are magically dependent trees that need magic, water, air, soil, and sunlight to survive. They are only found in tropical or temperate rain forests.

Spy Grass: A small flowering plant, not much different than a dandelion, spy grass is the bane of secrecy. Spy Grass has developed an unusual survival method; it telepathically scans a passing creature's mind to learn of the "best location" for its growth and reproduction. The spy grass then slowly moves to that location at a speed of six inches a day. For those who can communicate with plants, spy grass provides additional information. If the communicator can sway the plant from its normal unfriendly attitude to friendly or better, the person gains a window into the minds of those who have passed by within 10ft. of the plant. This provides the person with knowledge of who (or what) has passed in the past week and, if the spy grasses attitude is helpful, the person gains access to a single train of thought of every scanned creature. This memory could be important or trivial. Identifying spy grass requires a DC 20 knowledge (nature) check or a spot check of DC 25 to notice the plant has moved and then a DC 15 knowledge (nature) check. Spy grass is a magically dependent plant that needs magic, sunlight, water, air, and soil to survive. Spy grass is found in temperate and tropical environments where grass or flowers are found.

Subtle Creeper: This greenish yellow creeper attaches itself to the subtle topography as opposed to the physical topography. This leads to masses of apparently floating vegetation, as the creeper often doesn't touch any physical object at all. Some creepers appear to grow from the ground, but are just growing from where the subtle topography matches the physical topography. These particular "grounded" creepers then seem to grow up into thin air. Thankfully, subtle creepers are slow growing plants with low reproductive rates and rarely grow thicker than a thin rope. Birds (and stirges) often use subtle creepers, weaving them into very safe aerial nests. Subtle creepers are magically dependent plants that need magic, sunlight, and air to survive. Subtle creepers are found in all temperate and warm environments.



Trollsbane: Trollsbane is a tasty herbal plant that looks much like the typical onion (DC20 knowledge (nature) to identify) and tastes almost exactly the same (trollsbane is a little more acidic). Trollsbane receives its name from its magical defenses. An hour after ingestion, the eater's skin starts to secrete a strong acidic substance for the next two days (DC20 fortitude save negates). Although the individual is immune to the substance, anything the creature touches suffers 10hp of acid damage per round. This damage ignores hardness. For trolls however, this process stops their natural regeneration without provoking the acidic secretion, which opens them to the vicious culling typical of a band of trolls. Most trolls who ingest trollsbane find themselves eaten by their own tribe. Other creatures often refer to this plant as "Skyclad" because wearing any clothing is impossible while the oozing lasts. A creature can only imbibe a dozen or so trollsbanes in their lifetime because eventually the acid starts to affect the imbiber, killing all but the heartiest. Many attempts have been made to contain the acid secretions, but as of yet, no method has been successful in stopping the acid's breakdown into a neutral substance within a day. Trollsbane is a magical plant that needs air, water, soil, magic, and sunlight to survive. It is most common in forests and in wet, marshy areas.



Common Dyes

Colorant	Source	Color
Animals		
Coccus ilicis insect	Ground dried bodies of females	Red (kermes)
Cuttlefish, squid, octopus	Ink sack	Dark brown/black
Lac insect	Secretion	Red and blue
Mollusk	Gland fluid	Tyrian purple
Purpura shellfish	Secretion, oxidizes when exposed to air	Red/blue violets
Plants		
Agrimony	Leaves and stalks	Golden yellow
Bixa orellana	Fruit pulp	Red-orange (annatta)
Comfrey	Leaves	Deep yellow
Cutch	Gum resin	Brown
Elderberry	Berries	Lavender
Heather	Tips	Pale green
Hyssop	Leaves	Forest green
Indigo	Leaves of the plant fermented into paste	Deep blue
Lily of the valley	Leaves and stalks	Kelly green or beige
Madder	Ground root	Deep rich reds
Onion (red)	Skins	Maroon
Parsley	Leaves	Yellow green
Safflower	Flower	Yellow
Minerals		
Azurite	Powered	Blue
Brown clay	Powered	Ocher
Chalk	Powered	White
Charcoal	Powered	Black
Cinnabar	Powered	Vermilion
Green clay	Powered	Umber
Hematite	Powered	Red
Lapis lazuli	Powered	Blue/green blue
Malachite	Powered	Green
Orpiment	Powered	Yellow
Realgar	Powered	Orange

Comments

A CRUDE ATTEMPT. BANAL, TRITE AND BORING. SHOWS ONLY THE MOST BASIC OF UNDERSTANDING. ADEQUATE. D-

~GWARL, GOD OF MAGIC, THE REVEALER, HE WHO SEES ALL, THE WATCHMAN, THE LUMINARY, THE ONE ASKED.

Complex and thorough. Excellent content and presentation, A+.

~Dieonvar, Goddess of Fertility, The Fruitful, The Progenitor, The Great Mother, The Prime Mover, She Who Scolds the Stupid, The Milk Bringer, The Lusty.

LACKING IN THOUGHT AND SHOWING NO UNDERSTANDING OF GODLY COMPLEXITY. USEFUL FOR STARTING A FIRE. THE GNOME SHOULD BE PUNISHED. F.

~ALHENATAN, GOD OF DEATH. BEARER OF NO NAMES.

Acceptable. Shows a decent grasp of the basic concepts of world building. Could use more complex weather examples. For instance, he should have mentioned how when the planet moves, the part receiving the direct rays of the sun shifts, and how such shifting changes the prevailing wind patterns. He also forgot to mention anything explaining how planets go through hot, cold, and even iceball stages. Monsoons? fronts? Nice penmanship. C.

~Graleos, God of the Wind, Bringer of Rain, Bolt-Wielder, Justice of the Meek, Destroyer of Hope, Sun-Driver.

Well Done! Good Show! A+.

~Lord Persival Unprorious, God of Fellowship, Bringer of Good Tidings, He Who Speaks No Ill, Delight of the Seven Realms, Whisperer of the Body Magic.

Could have used a map showing the biomes of the base planet. Poorly researched and so general as to be almost useless. The lack of specific notes makes it impossible for the reader to check sources. It didn't tell me anything I didn't already know. F.

~Gralak, God of Wisdom, Keeper of Ancient Knowledge, The Great Librarian, The Tome Keeper, The Listener.

Wonderful! The best I've ever read. Simply excellent! A++.

~Ungruk, Goddess of Famine, Wife of War, She Who Feeds the Rich, Trampler of Justice.

Needs polish, but generally correct. Brief and eludes some important factors. An acceptable basic primer for godlings possessing little prior knowledge of universal matters. Good bibliography for real study. B-

-Pocinsil, Goddess of Terror, She Who Rules The Night, The Fear Mother, Bride of Fear and Blood, Moon-Bringer, The Jaws that Bite.

Weighted Score: C-. Satisfactory.

Hi, Kierian. Now you're a member.

~Noj, God of Creation, The God Maker.

Using A Magical Society: Ecology and Culture

When we thought of this book after winning three golden Ennies awards at last year's GenCon, we knew we had our hands full. Producing a single book that explains the complexities of world building, ecology, and the development and behavior of culture? Talk about a daunting task! Through our reading (check the bibliography for some truly great works), we've harvested the bounty of historical and scientific knowledge and distilled it into game useful information.

Since you've made it this far, we know you like the book, but because it's so unlike every other published D20 system book, we thought to share some of our ideas behind the writing of A Magical Society: Ecology and Culture and how you can apply it to your game. Like our first book, A Magical Medieval Society: Western Europe, A Magical Society: Ecology and Culture is designed to increase your knowledge about the environment your players interact with as they game. We packed MMS:WE with knowledge to help you run a medievaesque game. We've packed MS:EC with information regarding the entirety of your world. As opposed to focusing on one particular location, we've broadened our scope, providing knowledge that increases the overall enjoyment of your world.

Most gaming books are designed to provide mechanics that support a particular flavor of gaming. This paradigm is usually great, but the standard formula is inadequate when discussing world building activities. Most GMs don't want, nor need, a randomized system of world building according to tables and charts. We need to know how things work so we can make what we want to happen, happen. And, although this is a fantasy game, we also want to know what we've made is close enough to the real world to help players suspend their disbelief and focus on role-playing.

It's with this in mind that we wrote A Magical Society: Ecology and Culture. The sections on mapping your world should have obvious gaming benefits. They're a quick guideline in making plausible worlds that are pleasing to the eye. The information provided should lead you to a world that could happen, providing a framework for the fantastic. Knowing where the rain belts are on your planet may not seem that important, but once the environment is rooted in reality, the effects of magic are that much greater. A world where deserts and jungles meet, where rivers commonly flow uphill, and where winds always blow in the direction the players wish to sail can make for great gaming. As long as everyone's having fun, whatever's going on in the environment is perfect, no matter how unreal. But magic really comes to the forefront when it is uncommon. If your world mimics Earth, the magical changes you put into your world become that much more impressive, and once your players start to understand how the natural world works, the disruption of the natural becomes even more engrossing.

What we GMs really do is create a setting, populate that setting with interesting things, and then interact the setting with the players. In order to create great settings, we need to understand what's going on within a setting. Every part of the ecological sections is waiting to be pulled out and focused upon as a foil for some action in a game. Every GM has had their players on the edge of their seats just by saying, "You notice the crickets have stopped chirping." The information in this section provides you (and your players) information on what is natural. And once the natural environment has been set, small disturbances become more foreboding. Horror authors know that taking the normal and slowly changing it creates tension in the reader. This same tension can be created for players by slowly changing their environment until they're holding their breath on every word, certain that the next syllable spells doom. The expectation of action can be as enjoyable as action itself, and a reasonable period of expectation makes the action more satisfying. Killing the villain who's plagued the PCs for years is more enjoyable than simply slaughtering the next adversary. The same can be said of your environments.

The two ecology sections explain what's on your map. They add depth to your creation. The explanation of predator-prey relationships gives you knowledge to create some truly unusual monstrous challenges for your PCs while providing information on how food webs and energy flows. These ideas will be fully expanded upon in our forthcoming book, *A Magical Society: Aggressive Ecologies* (2005), but you can start working on your strange and dangerous environments right now. If you have outdoorsy characters, how ecologies deal with energy flow is particularly interesting. Righting a disrupted environment can be a great adventure for a druid or ranger, and each section should include enough information to help you build the setting for just such an adventure. They'll challenge your players in different ways and create unique experiences.

The culture section is another obviously useful addition to any GM's knowledge base. How people adapt to extreme environments, how knowledge disperses, what physical things a society makes, how rites and rituals influence daily life, and how people interact are all part of every well-run campaign. This section provides additional interest and depth to every world because it asks the right questions, leaving each GM to come up with the answers they prefer for each of their cultures. Again, most GMs don't want, nor need, charts and tables randomizing their cultures. In fact, after reading our culture section, we hope you'll see how the environment and the cultures around them influence every society. Randomization would probably be more detrimental than beneficial in the long run.

The appendix is like walking over the earth and picking up bits and pieces. Animals, plants, unique and interesting places, valuable materials and foodstuffs, and pages of magically dependent creatures all deepen your players' immersion in the environment you create for them. Every entry provides a good idea for a role-playing encounter, and it takes little more than a hop, skip, and jump to move mundane creatures into the realm of monstrous. The weirdness of nature often fits right into a magical world. The appendix also makes populating your world easier: each unique location can be placed on your map, each creature placed in its appropriate biome, and every valuable accounted for when considering how your cultures utilize that particular resource. Mapping, ecology, biomes, and culture give you the typical; the appendix gives you the exceptional.

However, to get the most out of this book we recommend you do a little additional work. Although we've tried to synthesize large amounts of complex information into a quick and useful gaming resource, we realize that one of the most powerful ways to reach your players and to get them deeply into your game is through visual aids. Unfortunately, we simply can't provide visuals for the hundreds of unique things in this book, but there is one place where images of all these things are accessible: the Internet. Jump online and look up any of the entries in our appendix, and you'll find breathtaking imagery that's only a print button away from entering your world. Again, the hardest part of creating a great environment is knowing what questions to ask.

We hope this book provides those questions.

Joseph Browning and Suzi Yee
Expeditious Retreat Press
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