PHIL EKLUND'S

BIOS MEGAFAUNA™

DINOSAURS VS. MAMMALS

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SIERRA MADRE GAMES

Post your questions or experiences about Megafauna in www.yahoogroups.com or boardgamegeek.com. Download the latest living rules from the files section!

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In memory of our slain playtester Gabe Zimmerman

1.0 INTRODUCTION

A quarter billion years ago, the Permian Extinction killed off almost all plants and animals on Earth. Two surviving groups, both lizard-like, struggled to emerge as the dominant megafauna on the planet. Today they have evolved into many forms, yet these groups can still be differentiated by their teeth. The ancestor of dinosaurs had a sloppy bite, using uniformly-shaped teeth that were constantly replaced. The ancestor of mammals had a precision bite, using one set of teeth lasting its entire life.

These two groups fought for global dominance for 50 million years, but by the close of the Triassic, the dinosaurs reigned supreme. Unchallenged for 130 million years, they met their doom in a gigantic asteroid strike. Opportunistic mammals have dominated for the last 65 million years… but the contest isn't over. ***Bios: Megafauna*** *re-enacts this roller-coaster struggle for terrestrial supremacy.*

1.1 Bios Series

Bios: Megafauna is the successor to *American Megafauna*, which has been for 20 years the definitive evolution game. The Bios series is a set of natural history games spanning all of Earth's history. The next game in the Bios series is *Origins*, the only civilization game covering the last 125,000 years of human history.

1.2 Overview of Play

From 1 to 4 players start as a small unspecialized species of proto-dinosaurs (red or green figures) or proto-mammals (white or orange figures). These creatures are distinguished by *dentition*; some have long batteries of teeth better suited for masticating plants, while others have fewer teeth better suited for meat-eating. Each player starts with *genes* used to purchase *mutation* and *genotype* cards, used to evolve your species. Stacks of cards and inheritance tiles indicate the *dietary DNA* of your species, giving it adaptations such as long necks for browsing treetops. Markers on tracks record *roadrunner DNA*, attributes that help your species catch prey or avoid being prey, such as swiftness or aggressiveness. Tiles that have gone extinct are collected in an area on the map called the "tarpits". These tiles are distributed among the most populous players as victory points during four scoring rounds.

2.0 COMPONENTS

2.1 Components List

- 1 Rulebook
- 1 Mounted Map
- 108 Mutation, Genotype, & Placeholder Cards
- 144 Era and Inheritance Tiles
- 128 Wooden Animals (64 dinosaurs, 64 mammals)
- 15 white gene chips, 3 red marker chips

Note*: This game uses no dice.*

Important*: This game is deliberately limited to the components provided. If during play the Era tile pool runs empty, see Ending the Game (18.0).*

2.2 Dentition Code & Dynasty.

The **dentition code** defines how many teeth each player has, from 2 to 5. This is listed on each of your four **placeholder cards**, and is a permanent value for all your species.* The more teeth you have, the better your animals are at being a herbivore. The fewer teeth you have, the better your animals are at being carnivores.

Example*: The placeholder shown is for player Orange.*

Note*: The paleontologist silhouette on the placeholder cards indicates the size of a 6-foot tall human in scale to the animal shown.*

Placeholder Card

a. Least-Teeth Order. The **Least-Teeth order** is: 2-teeth (Red), 3-teeth (Orange), 4-teeth (Green), and 5-teeth (White). This order is used to see who goes first (4.1), to resolve scoring ties (4.4b), and to resolve dentition contests (13.4, 14.5).

b. Dynasty. Players are either Dinosaurian or Mammalian. This distinction is used when generating *genotypes* (7.4).

c. Player colors, dynasties, and dentition codes.

COLORS in least-teeth order	*DYNASTY*	*DENTITION CODE*	*Derived Animals (today's survivors)*
1. Red	***Dinosaurian*** *Dino-croc archosaur*	**2-teeth**	***Dinosaurs*** *(crocodiles, birds)*
2. Orange	***Mammalian*** *Dog-face cynodont*	**3-teeth**	***Placental Mammals*** *(carnivora, ungulates, primates, rodents, etc.)*
3. Green	***Dinosaurian*** *Chisel lizard diapsid*	**4-teeth**	***Rhyncosaurs*** *(lizards, snakes)*
4. White	***Mammalian*** *Two-tusker synapsid*	**5-teeth**	***Extinct Mammal Relatives***

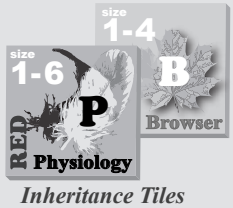
2.3 Cards and Tiles with DNA.

Cards come in three types: *placeholder* (2.7), *mutation* (7.1), and *genotype* (7.4). Tiles come in two types: *era* (2.4) and *inheritance* (10.3c).

a. DNA Code. DNA is encoded on cards and tiles by upper-case letters of the alphabet. Each letter records one attribute. The two kinds of DNA are **Dietary** and **Roadrunner**. Dietary DNA is in dark blue letters, and roadrunner DNA is in red letters.

b. **Dietary DNA Codes.**

B = Browser (ability to eat trees)
G = Grazer (ability to digest grass and shrubs)**
H = Husker (ability to shell nuts)
I = Insectivore (ability to eat small invertebrates)
P = Physiology (behavior & climate adaptations)



Inheritance Tiles

THE PERMIAN-TRIASSIC (P-Tr) EXTINCTION EVENT was a sudden and apocalyptic disaster of unknown origins that ended the Paleozoic Era and started the Mesozoic. This apocalypse killed off 96% of marine species and 90% of land species, both plant and animal. It is the only known mass extinction of insects. Photosynthesis shut down, and coal formation stopped. Forests were replaced by "redbeds", sandstone deposits indicative of warm arid deserts. Rivers worldwide became braided as the denuded land choked them with sediment. The deep oceans became hypoxic, as sea levels fluctuated. The signature is similar to the later Cretaceous-Tertiary (K-T) event that felled the dinosaurs, known to be impact-caused. But where are the blankets of debris, or the notorious tell-tale layer of iridium? The Permian event dumped more amounts of organic carbon into the atmosphere and oceans than any other time, far more than can be explained by the death of all the biota on the planet. This might be explained by massive methane releases from the continental shelves in the face of dropping sea levels, or by CO_2 outgassing from titanic flood basalts in Siberia.

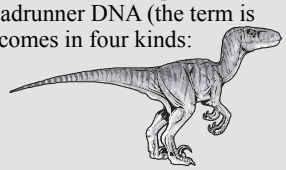
Gorgon*, by Peter Ward (2004)*

Extinction, How life on Earth nearly ended 250 million years ago*, by Douglas Erwin (2006)*

**SPECIES in this game actually represent animal orders.*

***Low plants, often armored with thorns and silica, require high-crowned teeth to process.*

c. Roadrunner DNA Codes. Roadrunner DNA describes adaptations to catch prey, or to avoid becoming prey. Roadrunner DNA (the term is inspired by the Warner Brothers cartoon) comes in four kinds:



A = Aggressive or Armored.
M = Marine.
N = Nocturnal or Burrowing.
S = Speedy.

d. Species Genome. The mutations of a species are encoded by a string of DNA letters called a **genome**. The **dietary genome** of a species is recorded on the cards and tiles in its stack. The **roadrunner genome** of a species is recorded by animals in four *roadrunner tracks* (2.5b).

e. Multiple Specializations. If a species has more than one copy of a DNA type, the results are cumulative.

***Example**: An animal with **SS** is speedier than an animal with just **S**.*

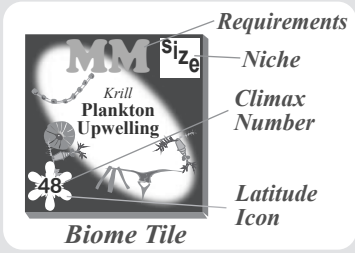
f. Stack. A species' dietary DNA is defined by its **stack**, composed of *mutation cards* (7.1), *genotype cards* (7.4) and/or *inheritance tiles* (10.3c) stacked on a *placeholder card* (2.7). It's possible for a stack to be active with just the placeholder card, as long as it has animals on the map.

2.4 Era Tiles (Immigrants & Biomes).

a. Color. Era tiles are divided into two groups: those with blue backs and pink frames (drawn during the Mesozoic Era), and those with white backs and white frames (the Cenozoic Era). The faces are also color-coded: orange = **orogeny** (mountain-building) biome, green = **terrestrial biome**, blue = **sea biome**, yellow = **land immigrant,** and light blue = **sea immigrant**. Orange and green biomes are collectively called **land biomes**.

b. Requirements. DNA is required to eat all biomes (except for *homelands,* 2.4f). These required adaptations are shown on the top edge of the tile, as a *DNA code* (2.3a).

***Example**: The plankton tile shown has requirements **"MM"**. To eat this tile, an herbivore needs at least two "marine" DNA in its genome.*



c. Niche.* All biomes have a **niche** listed in the small white square in the top right corner. It is not part of the requirements, but rather is used during *herbivore culls* (13.2).

***Example**: The plankton tile shown has a niche **"size"**, see 13.2b.*

d. Latitude and Climax.** Each biome lists a **latitude icon**: a snowflake, leaf, sun, raincloud, or triangle. This indicates the row of *habitats* that the biome starts in. A **climax number** is listed within the latitude icon, on a scale of 1 to 99. The lower the climax, the more likely the biome is to go *extinct*.

***Example**: The plankton in the previous example has a snowflake latitude icon with a climax of 48.*

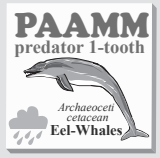
e. Orogeny Biome. These biomes are orange with a triangular latitude icon. The orogeny shown is *volcanic* (6.1e) with a climax of 93. Orogeny biomes only occupy mountain ranges and do not displace during *greenhouse level* changes (15.1a).

Orogeny Biome

f. Homeland Biomes. Four biomes represent the starting **homelands** of the players. They are unique in three ways:
(1) They have no *requirements* (2.4b), so any herbivore may eat them.
(2) They have a *color niche* (13.2c).
(3) The player Color is shown on their reverse.

Homeland Biome

g. Immigrant Era Tiles. Some era tiles represent foreign invading animals. They are labeled as "herbivore" or "predator", plus a *dentition code*. In the lower left corner is a *latitude icon*, the row of habitats that it enters. The immigrant's *size* is as marked if it's a herbivore. Predator immigrants are always the same size as their prey.



Immigrant Era Tiles have no climax number.

2.5 Map Tracks

a. Size Track. Each species uses an animal in this track to show its **size**. The sizes are abstracted from one (22 kg) to six (40 tons).

b. Roadrunner Tracks. Four tracks show levels of *roadrunner DNA* (2.3c): speedy (**S**), marine (**M**), nocturnal (**N**) and aggressive (**A**).

c. Cultures. Six areas indicate species tools and techniques, see 9.2.

d. Tarpit. This area stores dead plants and immigrants, see 16.1a.

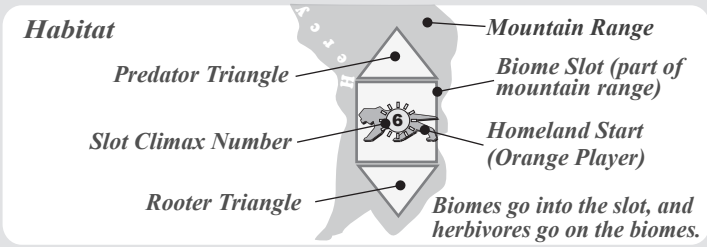
e. Greenhouse Level. This scale tracks global climate, see 15.0.

f. Ammonite and sunflower. Removal of disks from these spots trigger *episodes* per 17.0.

2.6 Map

The map shows North America as it was in the early Mesozoic Era.

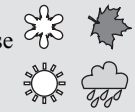
a. Habitats. The map is divided into 26 **habitats,** each with a square slot and two triangles. Each slot contains a *climax number* on the same scale as those on biomes (2.4d). See diagram below.



b. Predator and Rooter Triangles. Each habitat has an upper and lower triangle. The upper one is called the **predator triangle**, and the lower one is called the **rooter triangle**. Animals placed into the upper triangle are **carnivores** that are eating **herbivores** in the biome and rooter triangle. Animals placed into the lower triangle are *rooting* herbivores that are eating nuts or roots (12.0b).

c. Mountain Ranges. There are two north-south mountain ranges marked in orange on the map. Each range has three slots, bordered in red. Mountain-building tiles called *orogeny biomes* (2.4e) will appear in these two ranges during the game. Either orogeny or non-orogeny tiles can occupy a mountain range slot, however.

d. Latitudes. Each row of habitats is called a **latitude**. These are labeled "arctic", "jet stream", "horse latitude", and "tropical" latitudes. Note there are two rows of tropics.



e. Empty Habitats. Habitats that don't contain a biome are sea if the greenhouse level is very high (top two spots), and land otherwise (see 15.2). This is significant during *migration* (11.1).

2.7 Placeholders

Sixteen cards in the deck act as **placeholders** for the player's species stacks. Each player gets four of his Color, each with a different **silhouette** (animal token shape).

2.8 Animals

Each player color has 32 wooden **animals**. These are in four shapes, representing the four species that each player is allowed.

DENTITION Mammal teeth come in two sets: milk teeth and permanent teeth. Both sets are sculpted to fit together precisely (called an *occluded bite*), contrasted to the dinosaur's rather slapdash bite with dental batteries that are continually replaced. The life span of mammals is limited by tooth wear; consequently most of them plateau at a maximum adult size. Dinosaurs, with their uniform ever-growing teeth, themselves grow throughout their lives, up to the biggest land beasts ever.

a. Animals with the minimal **2-tooth** dental formulae are favored for a "snatch and gulp" predatory style. Their semi-specialized teeth are curved, flattened, and serrated for cutting off chunks rather than grabbing. Teeth are replaced as they are lost.

b. Mammals with **3-tooth** dentition have four kinds of teeth: incisors for biting and cropping, canines for holding prey, pre-molars for crushing, and molar "cheek teeth" for chewing. (In most mammal herbivores, the canines are absent, leaving a gap called the *diastema* between their biting and chewing teeth.)

c. The **4-tooth** dentition, based upon the peculiar herbivorous rhynchosaurs, features biting tusks (actually extensions of the jawbone), and shearing 'blade and groove' teeth. The rows of teeth were not replaced in the conventional reptilian fashion. Instead they were shuttled into the tooth-field in a conveyor-belt manner superficially like the elephantine system. The oldest teeth are resorbed as they move forward.

d. The **5-tooth** dentition augments the usual mammalian arsenal of incisors, tusks, and cheek teeth with reptilian beaks and horny palates. It is based upon the long extinct dicynodonts. The lower jaw retracts as the jaw closes, providing shearing action and grinding of vegetation on the palate. ***Tetrapod Zoology**, by Darren Naish (2009)*

**NICHE defines the competition for a resource. In theory, the fittest species will edge out all competitors "in the long run". In fact, ecology is so dynamic that a "long run" equilibrium seldom occurs.*

***CLIMAX defines the maturity of a community, as a culmination of an ecological or evolutionary succession.*

3.0 SET-UP

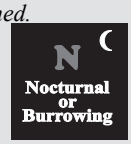
3.1 Each player is randomly assigned a Color.
The player gets the 32 *animals* and the 4 *placeholder cards* of this color.

3.2 Receive starting genes.
The player with the *least-teeth* (2.2a) gets 3 genes (white disks simulating genetic variation). The remaining players get 4 genes each.

3.3 Start with 5 inheritance tiles.
Each player takes the five *inheritance tiles* (10.3c) marked with his Color.

***Note**: Your stacks and genes are open and can be freely examined.*

***Optional**: The 16 roadrunner tiles (an example is shown) may optionally be used by any player to help keep track of his species' roadrunner DNA, but they have no effect on gameplay.*



3.4 Start the Mesozoic and Cenozoic Era pools.
Divide the *era tiles* into two face-down pools according to the color on their reverse side: blue (**Mesozoic**) and white (**Cenozoic**). Set aside the four *homeland tiles* (2.4f).

3.5 Place random biomes on the map.
Draw 22 Mesozoic Era tiles at random and put each on the map as follows:

a. Non-orogeny Biomes. If a *terrestrial* or *sea* biome is drawn, put it into the latitude indicated by its *latitude icon* (2.4d). Choose the slot in this latitude having the *lowest-climax* per 3.5c. If this slot is occupied, replace it with the new biome. Put the old biome in the *tarpit* (16.1a).

b. Orogeny Biomes. An *orogeny* biome is always put into one of the six slots in a *mountain range* (2.6c). For the set-up only, choose the *lowest-climax* slot in the eastern (Hercynian) mountain range. Again, if this slot is occupied, replace it with the new biome.

c. Determining the Climax of a Slot. If a slot is empty, its climax is as printed on the map (2.6a). If a slot is occupied (by a previously-placed biome), the climax is as printed on the biome tile occupying the slot (2.4d).

d. Immigrants. Tiles with no listed climax are *immigrants*, see 2.4g. Each one drawn is discarded out of the game without being replaced.

***Note**: Ignore the greenhouse shifts of volcanos that appear during set-up.*

3.6 Place your placeholder cards and animals.
Place your four *placeholder cards* (2.7) in a row in front of you. These cards are permanent, and indicate where your four species stacks will go. Put all the animals of your Color on or near your placeholder card with the matching silhouette. Each card should have 8 animals.

3.7 Place your size animal, map animal. and homeland.
Your starting species is the placeholder card labeled **archetype.***

a. Place Size Animal. Archetypes start at size one. Place one of your *archetype animals* in the size one block of the *size track* (2.5a).

b. Place Homeland and Population. Place your *homeland biome* (2.4f) face-up in the biome slot identified with the silhouette of your color. Remove any biome already occupying the homeland slot and put it into the *tarpit* (16.1a). Put one archetype animal on top of your homeland.

***Note**: Do not use homelands for players not in the game.*

3.8 Start the four Period Decks and the two Displays.
Shuffle the deck and place cards face-down into four side-by-side decks as indicated below. You may store these in the box lid, which has indicators for these decks.

a. Triassic Period Deck - Number of cards = 3 times the number of players.

b. Jurassic Period Deck - 5 cards.

c. Cretaceous Period Deck - 8 cards.

d. Tertiary Period Deck - 7 cards.

Beginner's Game: Remove all the Genotype Cards (see 7.4 & 7.5) before starting the decks.

e. Display. Draw 10 random cards from the general deck and lay them face-up side-by-side in two rows of five, one above another. The lower row is the **Lower Display**, and the upper row is the **Upper Display**.
Note: In the two-player game the use of the Upper Display is optional. For instance, the example 20.0 does not use the Upper Display.

3.9 Place the Atlantic Rift, Era, and Greenhouse Disks.
a. Atlantic Rift and Era. Place a clear red disk in the "ammonite" (Atlantic Rift", 5.2d) and "sunflower" (Era Disk, 5.2d) spots.

b. Greenhouse Level. Place a clear red disk on the Greenhouse track on the map, in the 800 ppm "start" spot. See *Greenhouse* (15.0).

**ARCHETYPES are the original forerunners of an animal dynasty. The archetypes in this game are similar - small and unspecialized tetrapods with general digestion. They walk on their soles (plantigrade) with an up and down backbone flexure.*

4.0 SEQUENCE OF PLAY

4.1 Player Order.
The player with the *least-teeth* (2.2a) goes first, thereafter play goes in clockwise order.

4.2 The **current player** chooses one of the following four (optional: five or six) **actions** to perform:

a. Purchase and play/discard a card. Purchase one card in either of the displays per 5.0, and play it per 7.0. Then draw a new card, resolve its event per 6.0, and finally use it to replenish the display. See 20.0 turn 2.

b. Resize one of your species. Move a *size animal* by one spot per 8.0. See 20.0 turn 1.

c. Acculturate one of your species. If you have the two requirements, add an animal from your reserves to a *culture* per 9.0. See 20.0 turn 18.

d. Expand an animal. Add an animal from your reserves to a habitable habitat within its *migration range* (11.0) from a chosen parent per 10.0. You may expand with the same silhouette as the parent, or a new one. Your destination can be any habitable triangle or biome. See 20.0 turn 4.

e. Roadrunner action (optional). Place 2 genes on the leftmost card in the *Lower Display*, and adjust the roadrunner of one of your animals by a step. If this animal has predator(s), they may similarly adjust a step (for free).

f. Genetic drift (optional). Steal one gene from the player who has the most genes, or is tied for the most genes.

***Important**: Because one animal is dedicated to tracking the size of a species, all species are limited to seven animals on the map, cultures, and roadrunner tracks. If you run out, you can't acculturate, expand, or mutate with new roadrunner with that species.*

4.3 Herbivore & carnivore contests, and final culling.
To end your turn, perform *herbivore contests* per 13.0, and then *carnivore contests* per 14.0. *Cull* (remove from the map) any animals or immigrants that have lost contests or have no food.

Check the game pieces at the end of the turn for the following:

a. Habitats. Every biome and triangle should have no more than one animal. (Exception: a predator triangle above a rooter biome with both an herbivore and a rooter might contain 2 animals).

b. Food. Cull any carnivore unable to eat its prey due to roadrunner or size (14.1), and any herbivore not adapted to eat the biome it is on.

c. Stacks. Discard any card or return to your reserves any tile outside its *size-range* (7.2).

d. Display. Because of 5.0e, each display should have 5 cards.

4.4 Scoring Rounds
A **scoring round** occurs at the end of a turn that the last card of each *Period Deck* (3.8) is drawn. During each scoring round, tiles from the *tarpit* (16.1a) are awarded to the most populous players.

a. Count Population. Your **population** is the sum of all animals on the map for all your species. Animals in *super-fern* habitat (6.1f) count triple.

***Example**: A rooter habitat contains two herbivores (one is a husker) feeding on it, and two carnivores in its triangle. Each of these animals scores one population.*

b. Determine the Leader. The **leader** is the player with the most *population* (4.4a). Ties go to the player with the most genes. If there is still a tie, go in *least-teeth order* (2.2a).

c. Determine the Second, Third, and Fourth Place. These players are determined by the same method as for the leader.

d. Award the Tarpit Tiles. The leader draws half of the tarpit tiles, rounding up fractions. Thus, if there is one tile in the tarpit, he gets it. If there are three tiles, he gets two. If there are tiles remaining, the second place player takes half of the remaining in the same way. And the third, and finally the fourth place players take their share.

e. Fossil Record. Keep your tarpit tiles as a permanent **fossil record**. Each is worth a victory point at the *end of the game* (18.1).

***Important (Lazarus Players)**: You must have map animals to be awarded tiles from the tarpit.*

***Example**: There are 10 tiles in the tarpit when the scoring occurs. Red and Orange have three map animals and no genes, White has one map animal, and Green is a "Lazarus" with no map animals. Red gets 5 tiles, Orange gets 3, White gets one, and one remains in the tarpit unclaimed.*

***Note**: You may not sell, donate, or trade cards, tiles, or genes.*

5.0 PURCHASE A CARD.

If you have enough genes, you may purchase one of the five cards in one of the displays. The ones to the right are the most expensive.

a. Cost. The cost of each card in a display is determined by its position in the row. The card furthest to the left is free. The cost of each of the other cards costs one additional gene as you move to the right. You pay this cost by dropping one gene on each of the cards situated to the left of the card you are purchasing.

b. Genetic Enrichment. If the card you select contains genes (dropped by players who previously passed up this card), you acquire these genes (only after you pay for the card, however).

***Example**: A player wishes to buy the genotype card that is the third from the left, which has one gene sitting on it. First he puts one gene on each of the two cards to the left of it. Then he takes the card and plays or discards it, and pockets the gene that was on it.*

c. Play Card. The card you purchased must be played immediately per 7.0, or else discarded out of the game. There is no hand. *Note: You may purchase a card just to discard it and get the genes that were on it.*

d. Draw New Card. After purchasing a card from the *Lower Display* (3.8e), draw a new one from the top of the current *Period Deck* (3.8) and resolve its event per 6.0. This impacts all players. After purchasing a card from the Upper Display, draw a new one from the general deck, but ignore its event.

e. Replenish Display to 5 Cards. After the event is resolved, place the new card into the rightmost position in the display row . This brings the display back to 5 cards in a row. Shift cards to the left to fill the gap left by the card removed. See 20.0 turn 2.

f. Scoring Round Trigger If this was the last card in the Period Deck, perform a *scoring round* per 4.4 to end the turn.

6.0 RESOLVE THE EVENT.

Events are listed in the dark blue band of every card. There are 4 types: *New Era Tiles, Catastrophe, Milankovich, and Erosion.*

6.1 New Era Tiles event.

Pick and place two new *era tiles* on the map. After placing the first, resolve its effects (including Greenhouse shifts) before drawing and resolving the second.

a. Era. Era tiles come in two eras: *Mesozoic* (blue back) and *Cenozoic* (white back). Draw the two tiles at random from the *current era* (17.2).

b. Biome Map Placement. If the tile drawn is a *biome*, put it in the *lowest-climax slot* (3.5c). An orogeny tile is placed in the lowest-climax slot in either of the two *mountain ranges* (2.6c). A non-orogeny tile is placed in the latitude corresponding to its *latitude icon* (2.4d).

***Note**: A non-orogeny biome can be placed into a mountain range.*

c. Replacement of Previous Biome. If the lowest-climax slot is occupied, that biome goes *extinct* and is replaced by the new biome. *The old biome is replaced even if its climax is higher than the biome replacing it.*

***Example**: The "Petrified Forest" biome is drawn. This has the "sun" icon, so it goes somewhere in the horse latitude. All the slots are occupied, and the lowest-climax is sea lilies. The forest replaces the sea lilies.*

d. Seas and Ice. If the greenhouse is at 3200 ppm, a new biome with a blue star ★ enters flipped over. It is treated as an uninhabitable sea biome (15.1e). If the greenhouse is at 200 ppm, a new biome with a white star ☆ enters flipped over. It is treated as an uninhabitable and impassible land biome (11.1d).

e. Volcanos. If the tile drawn is an orogeny biome marked with the **volcano icon** and the "greenhouse rises" arrow, raise the greenhouse level a step (displacing non-orogeny biomes north, etc. per 15.1).

f. Azolla Event.* If the tile drawn is marked with the "super-fern" and the "greenhouse down" icons, drop the greenhouse level a step per 15.1.

***Note**: The super-fern biome doesn't displace during Greenhouse events, and animals there score triple population (4.4a).*

g. Immigrants. A yellow or light blue tile indicates a land or sea immigrant has invaded over a bridge from another continent. This invader often has the upper hand until the locals evolve defenses against it. It enters in the latitude specified on its tile, stopping on the lowest climax biome (not slot) that it is adapted to eat. For an herbivore immigrant, this is any biome or rooter triangle it has the DNA for (13.1). For a predator immigrant, this is any habitat with prey animals it has *prey suitability* for (14.1). If no habitat in the latitude is habitable, move the immigrant tile to the tarpit.

Note (phenotype):* Sea immigrants (light blue) skip land habitats. Land immigrants (yellow) skip sea habitats. Amphibians (half blue/half yellow) can go to either.*

***Important (competition):** An immigrant will not enter a triangle or biome occupied by another immigrant. It will only enter a triangle or biome that is unoccupied or occupied by player species.*

***Placement:** Place the immigrant tile under its biome tile (if herbivore), in the predator triangle (if predator), or in the husker triangle (if husker).*

***Example (carnivore):** An **AAMM** eel whale immigrates into the tropics. The land biomes are skipped. The lowest-climax sea biome with prey has nocturnal prey, so this is also skipped. The next lowest has immigrant sea turtles, which the whales can eat. The whale tile goes into this predator triangle.*

***Important:** An immigrant competes with player animals during all culling phases per 13.5 and 14.4.*

***Example (herbivore):** A deer with the adaptations **BGPP** immigrates into the arctic. The lowest-climax biome that is edible is the ginkgoes (**B**), but sloth immigrants are already eating this. The only other alternative is the homeland for the Green Player. This biome is edible, so the deer tile is placed under it. Unfortunately for them, Green has an herbivore there, which enjoys the niche advantage. So the deer lose the herbivore contest and go to the tarpit.*

6.2 Catastrophic event.

A **catastrophic event** kills off overspecialized animals, then shifts the greenhouse up or down per 15.1. The first catastrophe splits the continent; the second advances the game into the Cenozoic Era.

a. Catastrophe Level. A **catastrophe level,** from 4 to 7 as printed on each catastrophe, describes the amount of DNA in a species' *genome* (2.3d) that will drive it extinct. Count the number of DNA letters in a species' *genome* (2.3d), including the dietary DNA recorded in its cards and tiles, and the roadrunner DNA recorded in its roadrunner tracks. If the number of letters is greater than or equal to that specified by the catastrophe level, that species becomes *extinct* (16.0).

***Note**: Catastrophe extinctions impact both immigrants and player stacks.*

***Example**: An asteroid hits the Earth. The card states "Extinct if ≥ 5 DNA." (The notation "≥" means "greater than or equal to".) An animal with **BGGAN** would be killed, because it has five DNA. An animal with **PPAM** is spared.*

b. Episode Trigger. The first and second Catastrophe event of the game triggers an *episode* (17.0), after all other catastrophe effects are resolved.

6.3 Milankovich event.

Earth goes through periodic oscillations in its orbit that drive its climate. Each Milankovich event specifies one or two *latitudes*, and the lowest-climax biome in each latitude specified goes *extinct* (16.1).

***Example**: A Milankovich P event alters the arctic and horse latitudes. The lowest-climax in the arctic are ginkgoes, and in the horse latitudes are horsetails. These go to the tarpit. Any herbivores eating these biomes, plus any carnivores eating the herbivores, are culled.*

6.4 Erosion event.

This lowers the greenhouse as well as mountains, but shuts down during an ice age. If the *greenhouse level* is 800 ppm or more, first remove as extinct the highest-climax *orogeny biome*. Then lower the greenhouse one step per 15.1.

MILANKOVICH CYCLES describe how climate is nudged by periodic oscillations in the Earth's orbit. These oscillations are caused by the alignment of the planets, especially Jupiter. (I bet you weren't expecting astrology to enter this game!) There are three sorts of orbital changes. Changes in the Earth's eccentricity (E cycle) reapportion annual solar energy to different parts of the year. Changes in the Earth's precession (P cycle) alter the seasonality (temperature differences between poles and equator) that drive the equatorial winds and weather. Changes in the Earth's tilt (T cycle) change the amount of midnight sun and seasonality, especially at the poles.

EROSION AND GREENHOUSE. Although carbon dioxide levels rise and fall in response to biological and geological forces, over the long run levels have been falling due to carbon sequestering into rocks. This sequestering occurs during rock weathering (especially hydrolysis) and by coal formation (mainly from plant lignins which resist decomposition). Some of the sequestered carbon is returned by volcanos, but most is buried forever. And so temperatures have been falling since the time of the dinosaurs, particularly when erosion is accelerated by mountain growth. The orogenies forming the Andes and the Himalayas, and to a lesser extent the Laramides of America, have plunged us into our current ice age.

**AZOLLA EVENT. During the Eocene, a bloom of the freshwater Azolla fern turned the entire Arctic Ocean solid green. Dead ferns dropping into the hypoxic depths sequestered enough carbon to drop greenhouse levels from 3500 ppm to 650 ppm.*

Dr. John Douglass, 2011

***PHENOTYPE includes the distinguishing features of an individual resulting from both its genotype and its environmental interaction.*

7.0 PLAY A CARD

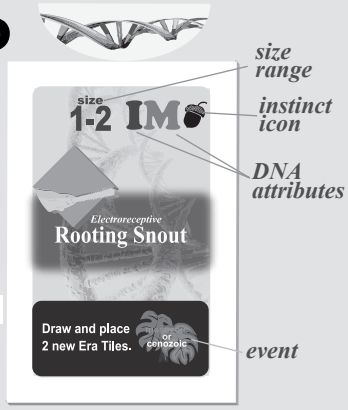
The two types of cards in the playing deck are *Mutation* and *Genotype*.

7.1 Playing a Mutation Card.

Mutate a living species by playing the **mutation card** you just purchased into its stack. This gives it the *DNA attributes* and *instinct icons* encoded in the upper right corner of the card.

***Example**: The card shown has **IM** DNA.*

***Important**: Inheritance tiles cannot be used for mutating.*



Mutation Card

7.2 Mutation Size Limits.

You may not mutate a species with a size outside the range on the card.

***Example**: A species at size 5 cannot get feathers (size-range = 1-4).*

7.3 Adding Roadrunner DNA.

If you mutate using a card with roadrunner DNA, your new roadrunner *genome* is reflected by adjusting the appropriate *roadrunner tracks* (2.5b). Your marker remains at three even if you have more of that roadrunner type.

a. New Roadrunner Animal. If the card used to mutate contains *roadrunner DNA* that you do not yet have, add an animal to that roadrunner track (**S, M, N,** and/or **A**) to reflect the amount of roadrunner acquired. This animal is called a **roadrunner animal**. If you're out of animals, you must discard the card instead of mutating with it.

***Note**: Each species can have only one animal in each roadrunner track.*

b. Wings. If you have three or more **S** DNA, and you are size 1, then you attain *flight* (11.0a). This gives you a *migration range* of 7 habitats, and can cross land, sea, or ice habitats.

c. Subterranean Colony. If you have three or more **N** DNA, and you are size 1, then you become a subterranean colony with the *social skills* instinct (9.1c).*

***Example**: Your species, starting from an **NN** roadrunner animal, is mutated using an **IN** echolocation card. Move your roadrunner animal to the **NNN** spot. If you reduce to size one, you gain the social skills instinct as a subterranean colonial animal.*

d. Whale Pods. A **MMM** species is awarded the *language* instinct (9.1d).

e. Fire-Bearing. An **AAA** species is awarded the *natural history* instinct (9.1b), and its homeland is immune from being *inverted* at 200 ppm (15.1d).

f. Amphibian. If a species with one **M** DNA (11.1c) gains more, it becomes a sea animal and all its animals in land habitats will die. If instead it loses its **M**, all its animals in sea habitats will die.

7.4 Playing a Genotype Card (Speciation).

Play a **Genotype card** to start a new species stack with a silhouette matching the one on the card. You must choose a parent species which has a size within the range specified, and which has at least half the DNA specified on the card (rounding up). For instance, if the genotype card has DNA **HSSS**, the parent must have either **HS** or **SS** DNA in its *genome*. Replace one map animal of the parent with a map animal of the child per 7.5. The child gains only the DNA on its genotype card (i.e. no inheritance per 10.3).

a. Child's Dynasty. The Red and Green are proto-dinosaurs, and must play the dinosaur side of the genotype card. White and Orange are proto-mammals, and must play the mammal side of the card.**

b. Child's Map Animal. You must replace one map animal of the parent with a map animal of the child. This must be in a place where the child can survive. Note that this replacement may drive the parent extinct.

c. Child's Size and Roadrunner Animals. Place a size animal at the same size as the parent. Place roadrunner animal(s) according to the roadrunner DNA (if any) on the genotype card.

***Example**: Green buys and plays the dove genotype card (size range = 1, DNA **HSSS**) into his placeholder. For the parent, he chooses a tiny species with foregut digestion (**HG**) and hopping (**S**), and thus meets the size and DNA requirements. He replaces one of the parent's map animals with an animal. He places a size animal in size 1, and a roadrunner animal in the **SSS** (wings) position. His new **HSSS** dove species is ready to take off! See 20.0 turn 20 for a further example.*

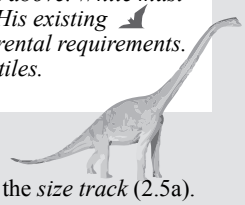
Genotype Card

7.5 Playing a Genotype Card (Fossil Record).

If you purchase a genotype card for a species that is already in use, then instead of creating a new species, you add the card to your *fossil record* (4.4e), where it will count victory points at the end of the game per 18.1a.

a. Parental Requirements. Under this option, the parent species must match the silhouette, size-range, and at least half the DNA of the genotype card. The parent species does not change as a result of this play.

***Example**: White buys the dove / tillodont card shown above. White must play the tillodont side (size range = 1-3, DNA **HN**). His existing species are size 3 and nocturnal, so they meet the parental requirements. He adds the card to his fossil record stack of victory tiles. Also see 20.0 turn 15 for a further example.*



8.0 RESIZE

You may grow or shrink your species by one step on the *size track* (2.5a).

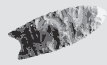
a. DNA Recession. If your species size goes beyond the range listed on a *mutation card*, discard that card out of the game. If your size goes beyond the range listed on a *genotype card*, put it into your fossil record. If your size goes beyond the range listed on an *inheritance tile*, return it to your reserves. *You may not voluntarily discard DNA from a stack.*

***Reminder**: Adjust the roadrunner track if you lose roadrunner DNA.*

***Note**: Loss of a mutation card doesn't impact inheritance tiles on any species (10.3c).*

b. Extra Predator Size Adjust (important). If your herbivore changes size, all predator species of that herbivore (both yours and your opponents') may immediately adjust their size by one as well.

9.0 ACCULTURATE



Acculturate a species by playing one animal from your reserves into one of the culture areas on the map. The species must have mutation cards containing the two instinct icons listed on the map as requirements.

9.1 Instinct Icons

Mutation cards with **instinct icons** confer those instinct when played.

a. Manual dexterity (ability to manipulate objects) is a requirement for cultures 9.2a, b, c.

b. Natural history (conceptual memory of natural phenomena) is a requirement for cultures 9.2b, e, f.

c. Social skills (the ability to specialize in a cooperative effort, and recognize individuals) is a requirement for cultures 9.2a, d, f.

d. Language (the ability to mentally store verbal concepts, and thus primarily used for communicating with yourself rather than others) is a requirement for cultures 9.2c, d, e.

***Note**: Instincts are not inherited (10.3). However, subterranean colony, whale pod, and fire-bearing DNA can be inherited, which confers instinct icons (7.3c, d, e). Instincts can be worth victory points, see 18.1b.*

RED QUEEN is named for the Lewis Carroll character who runs as fast as she can to stay in one place. It is applied to a species that exhausts its genetic variation just to maintain an arms race against protean diseases. It especially impacts large dense populations vulnerable to pandemics. The Red Queen hypothesis explains why sexual reproduction is vastly more common than asexual parthenogenesis in plants and animals. Traditional explanations of how sex increases long-term variation to benefit the species fail to show how sex helps the individual gene. This view of host vs. germ genotypes in an evolutionary arms race shows how sexual reproduction can benefit individuals directly. ***The Red Queen**, by Matt Ridley (1993)*

ECOMORPHS are megafaunal bodyplans that have withstood the test of time. They correspond to the game's silhouettes. For instance, the *tank* ecomorph is a burly quadruped with a low grazing mouth, a huge hindgut digestive vat, and a mean disposition. The *biped* ecomorph, like ground sloths and iguanodonts, rises on its hind legs to browse or defend itself.

**EUSOCIAL COLONIES feature biologically sterile "workers" serving a reproductive "queen". Examples include ants, bees, wasps, termites, and naked mole rats.*

***Apologia: Sometimes the dinosaur side will include creatures that are related to the dinosaurs, but are not actually dinosaurs.*

9.2 Benefits of Acculturation.

Each **culture animal** awards the benefits listed below.

***Important**: Each species may have only one culture animal in each culture area. It is removed only if the species goes extinct. In particular, the loss of a card with the instinct icon will not change the cultural advancement. Culture is not inheritable.*

a. Tool Use Culture. Requires manual dexterity and social skills. *Special: This species ignores size limitations on all mutation cards and tiles. It still must be at size 1 for flight or subterranean colonies.*

***Example**: A tool-using animal growing to size 5 keeps its feathers (as a cloak?), its **IN** digging claws (shovel?), and its **H** inheritance tile (nutcracker?).*

b. Bone-Cracking Culture. Requires manual dexterity and natural history. *Special (hand-axe scavenging of bone marrow): Carnivorous animals of this species ignore all size characteristics of its prey (14.1a).*

c. Projectile-Hunting Culture. Requires manual dexterity and language. *Special (atlatl): Carnivorous animals of this species ignore one roadrunner type possessed by its prey (14.1b-e). This may be a different type for each prey animal. (Projectile-hunters still require **M** DNA to enter sea hexes, however.)*

d. Division of Labor Culture. Requires social skills and language. *Special: Animals of this species always win dentition contests against those without Division of Labor.*

e. Agricultural Culture. Requires natural history and language. *Special: Herbivorous animals of this species treat empty slots next to your homeland (to the north, south, east, and west) as habitable habitats called **farms** (even if the homeland is inverted). This assumes you have the adaptations to enter them per 11.1a or b. Homelands being farmed are immune to extinction.*

f. Male Contests Culture. Requires natural history and social skills. *Special: Children of this species are not limited in their inheritance by 10.3b and c. They may inherit multiple types of roadrunner and dietary DNA.*

10.0 EXPAND AN ANIMAL

You may **expand** by adding an animal from your reserves to a habitable habitat on the map within its *migration range* (11.0) from a chosen parent.

10.1 Choose Parent.

The expanded animal is called a **child**. Choose one map unit to be its **parent**.

10.2 Choose Child Silhouette.

The child may use either the same silhouette as its parent, or a new unused silhouette of your Color. If the latter, it forms a new *species stack* that may **inherit** attributes from its parent per the next paragraph.

10.3 Inheritance.

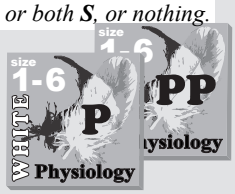
If expanding by creating a new species, the child inherits the *size* of its parent, and may also inherit one roadrunner and one dietary DNA type.

a. Size Inheritance. Place a **size animal** of this new child shape on the *size track* (2.5a), matching the size of the parent.

b. Roadrunner Inheritance. The child may inherit some or all of the parent's DNA from one roadrunner track. Adjust the roadrunner animal per 7.3.

***Example**: Your archetypes are cat-eyed hoofed animals, with a **NSS** genome. Your child species can inherit the **N**, one or both **S**, or nothing.*

c. Dietary Inheritance. The child may also inherit one or more dietary DNA owned by the parent, using a maximum of one **inheritance tile** from your reserves. Pick a tile that matches the DNA to be inherited and put it on the child's stack, on either its front or reverse side. (The reverse side of **B, G,** and **P** DNA is **BB, GG,** and **PP** respectively. The reverse side of **H** is **B**, and of **I** is **G**.)



Both sides of an Inheritance Tile.

***Important**: Use inheritance tiles to show what a child has inherited from a parent who already has that DNA. Never use them to mutate a species!*

***Note**: Cards or tiles in the parent's stack can't be donated to its child.*

***Important**: All inheritance tiles list a size-range. A child may not inherit a tile if it is outside the size-range specified.*

***Example**: A child expands from a saber-toothed (**AA**) trunked (**B**) parent. The player decides the child will inherit **AB**. He adds a roadrunner animal to the **A** spot in the track, and uses his **B** inheritance tile to represent its inherited trunk.*

10.4 Choose Destination.

The child may enter a habitat no further from its parent than the child's *migration range* (11.0). If the destination is a biome or rooter triangle, the child must have the DNA to eat it. If the destination is a predator triangle, the prey there must be *suitable* for the child to eat per 14.1.

***Note (omnivorous):** It is possible for a single species to have both carnivores and herbivores. However cannibalism is disallowed; a predator may not feed on an herbivore of the same species.*

***Important:** An animal may be placed in an overcrowded habitat, but if it loses the contest, it will be culled at the end of its turn.*

***Example:** A chipmunk eating nuts in a rooter triangle notices a small defenseless prey animal nearby. The chipmunk expands a new animal that moves to the predator triangle of the prey's habitat.*

11.0 MIGRATION RANGE*

A species **range** is a maximum number of habitats it is allowed to spread while expanding to a new habitable habitat. This range is a path moving from habitat to habitat, moving directly north, south, east, or west. (No diagonal moves.) The range is equal to the species *size*, as shown on the *size track* (2.5a) plus one for each **P** DNA it has. *Flying animals* (7.3b) always have a range of 7.

11.1 Migration Obstacles.

The **S** and **M** roadrunner tracks list limitations on the habitats that animals may enter while tracing the migration path.

a. Land animals. Animals (including immigrants) with no **M** DNA may not enter *sea biomes* or *slots* (2.4a and 2.6e), unless they can fly.
***Note:** Animals are allowed both **S** and **M** DNA at the same time.*

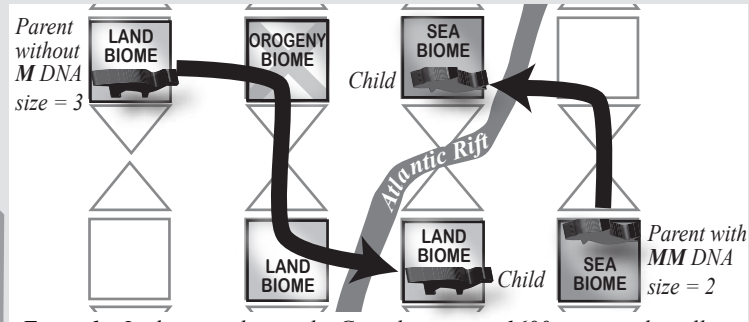
b. Sea animals. Animals with two or more **M** DNA may not enter *land habitats* or *slots* (2.4a and 2.6e), unless they can fly.

c. Amphibians. Animals with exactly one **M** DNA are called **amphibians**. They can enter land and sea biomes and slots, but their migration range is one less, as marked on the roadrunner track.

***Example**: A size one seal may only migrate within its habitat. It may, for instance, switch from the predator triangle to the biome.*

d. Ice Habitats. Only flying animals are allowed to enter **ice habitats** (biomes inverted per 15.1d during a 200 ppm greenhouse).

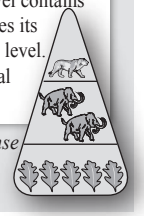
MOVEMENT EXAMPLE



***Example**: In the map shown, the Greenhouse is at 1600 ppm, so that all empty slots are sea. Two parents are shown, one a size 2 sea animal, the other a size 3 land animal. Since range = size, the sea animal may expand a child to place no more than 2 habitats distant, as shown. It travels over sea biomes or slots only. The land animal expands a child to a place 3-habitats away, traveling over land. If the Atlantic has formed, the only the sea animal can complete its move.*

ARCHAEOLOGICAL CULTURES are diagnostic assemblages of tools and techniques. These include hand-axes (3 million years ago), fire-bearing (one half million years ago), and Mousterian thrusting spears and Levalloisian blade spears (one quarter million years ago). Multi-part tools need to be visualized prior to assembly. This visualization is accomplished in the brain using stored lingual concepts, explaining the necessity or language for true technology as opposed to instinctive tool use. See: **Origins, how we became human.**

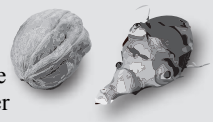
TROPHIC LEVEL describes a triangular nutritional hierarchy of life with top carnivores at the apex, feeding on the next trophic level, the herbivores. The lowest trophic level contains the energy-producing plants. The passage of energy between each level determines its biomass. In this game, insectivores and sea-food eaters are in the herbivore trophic level. Dinosaur and bird orders can be divided into meat-eaters and leaf-eaters. Mammal orders, more omnivorous in their trophic choices, can't be so cleanly divided.



EMPTY SLOTS at the start of the game may be considered sand dunes. Much of the interior of the Pangaea supercontinent was covered in sand during the Triassic.

**MIGRATIONS are the mass movements of organisms, either seasonal or in response to environmental hardship. The game migration rate is based upon size three American megafauna like bison and caribou, which migrate 2500 km annually.*

12.0 ROOTER BIOMES



Rooter Biomes have 2 rows of *requirements* (2.4b). The upper row is for herbivores that eat leaves, and the lower row is for **rooters** that shell nuts/seed-cones (**H** husker DNA) or dig for tubers/rhizomes (**N** burrowing DNA). Thus, a rooter biome is effectively two biomes, able to support four animals: one eating foliage (on the biome), one eating nuts/roots (in the *rooter triangle*, 2.6b), and two carnivores (in the predator triangle).

Rooter Biome

a. Niche. Regardless of whether foliage or nuts/roots are eaten, the *niche* is the same (listed in the white square).

b. Rooter. An animal in the rooter triangle, called a **rooter**, is herbivorous and generally follows all the rules for herbivores.

***Example**: The cycadeoid biome shown can support an herbivore with **B** DNA, plus a rooter with **H** DNA. The two animals can be the same or different species. The niche for both is "**S**".*

13.0 HERBIVORE CONTESTS

Each biome can support one herbivore, plus (if a *rooter biome*, 12.0) one *rooter*. For each overcrowded biome (in any order), perform an **herbivore contest** by following steps 13.1 through 13.4 below to identify the losers. In case of a tie, go to the next step, until only one animal is left.

13.1 Biome Habitability.

Herbivores not meeting the biome *requirements* (2.4b) lose.

13.2 Niche Contest.

Each biome tile has a **niche** listed in the white box in the corner. The herbivores with the least amount of the niche attribute lose.

a. DNA Niche. If the niche is a *DNA code* (2.3a), the herbivore species with the least amount of that DNA in their genome lose.

***Example**: Both Orange and White have an herbivore in a habitat containing the Iberian Bog biome (niche = **I**). The white species has one **I** DNA, while the orange species has two. White is culled (removed) because it has less of the insect-eating DNA.*

b. Size Niche. If the niche is "SIZE", the smallest herbivores lose.

c. Color Niche. For the homelands, the niche is the player color. However, *farms* associated with homelands have no niche (9.2e).

***Example**: The cloud forest has niche "orange". Therefore, an herbivore of a different color loses if Orange has an herbivore there.*

13.3 Predator-Defense Contest.

Herbivores edible by one or more carnivores in the habitat lose. See *prey suitability* (14.1) to see if a carnivore can eat an herbivore.

***Example**: A moose and squirrel sit in a prairie. Since a biome can only support one herbivore, one must lose. The niche is "**S**", so if the squirrel is faster, he will prevail. But suppose neither is faster, but a predatory eagle too small to eat the moose is present. Now, it is the moose that wins.*

13.4 Herbivore Dentition Contest.

Herbivores with fewer teeth lose against those with more. Thus, 5-teeth wins over 3-teeth.

***Note**: If you have more than one adapted herbivore species of your color in a habitat, and neither has an advantage in niche or predator-defense, you choose which ones are removed. See 20.0 turn 20.*

13.5 Competition with Immigrants.*

An herbivore immigrant tile is treated exactly as an animal, using the DNA and dentition code shown on its tile. Since all immigrant herbivores have 6-teeth, they win dentition contests (except per 9.2d). If two immigrants compete, the one that is in the habitat first is the winner.

13.6 Losing a Contest.

Any animal or immigrant losing a contest is **culled** (returned to its owner or the tarpit respectively).

***Exception**: If in the same habitat, there is an empty biome or triangle that is habitable, the animal or immigrant moves there instead of being culled.*

***Example**: An herbivorous animal belong to the Red player is eating cycads. But a Green herbivore invades, and beats Red in a dentition contest. Red is allowed to move his animal to the unoccupied predator triangle of the cycad habitat, assuming he is suited in size and roadrunner to eat Green's invading animal.*

14.0 CARNIVORE CONTESTS

Each *predator triangle* can support one carnivore (or two if there are two prey animals, possible only in a *rooter habitat*, 12.0). For each overcrowded triangle (in any order), perform a **carnivore contest** by applying rules 14.1 through 14.3 below to identify losers. If tied, go to the next rule, until only one carnivore per prey animal is left standing. If an animal or immigrant loses a contest, move it to an unoccupied biome slot or rooter triangle in the same habitat, if it has the DNA to live there. Otherwise, it goes extinct.

***Important (circle of life)**: Herbivores are never removed from the map just because they are being preyed upon (see 13.3 though).*

14.1 Prey Suitability.

Carnivores can only eat herbivores, either player animals or immigrants. Carnivores not suited to eat their prey because of size or roadrunner die.

a. Size. Must be no more than one size different from its prey. For instance, if the prey is size 2, the predator can be size 1, 2, or 3.

b. Speed. Must have the same number or more "**S**" DNA than its prey. For instance, if the prey is **SS**, the predator must also be **SS** or faster.

c. Nocturnal. Must have the same or more "**N**" DNA than its prey.

d. Armor/Aggressive. Must have the same or more "**A**" DNA than its prey.

e. Marine. Must have the same or more "**M**" DNA than its prey.

***Note** (cannibalism): Predators may not prey on their own kind, see 10.4.*

14.2 Physiology Contest.

Carnivores lose against competitors having more **P** DNA.

14.3 Carnivore Dentition Contest.

Carnivores with more teeth lose against those with fewer teeth. (The fewer the teeth, the better the carnivore!)**

***Note**: In a carnivore dentition contest with more than one species of your color in a triangle, you choose which ones are removed.*

***Example:** Before culling, dino-crocs and chisel lizards both have a carnivore (without **P** DNA) in a triangle of a habitat containing both rooter and herbivore prey. Suppose dino-croc expands an additional predator into this triangle. If the dino-croc can eat both kinds of prey, the chisel lizard loses the dentition contest and is removed. If the dino-croc can eat just one kind, then the additional dino-croc animal has no suitable prey and is removed.*

***Note**: If two carnivores are eating two prey in a hex, both survive if they each have suitable prey. One carnivore (able to eat both prey) cannot starve the other by selecting his prey as food.*

14.4 Competition with Immigrants.

A predator immigrant tile is treated exactly as a carnivore animal, using the DNA and number of teeth shown on its tile.

a. Size. Immigrant predators are automatically the same size as their prey.

b. Immigrant Dentition Code. Immigrant predators have only one-tooth.

***Example**: Three carnivores are competing to eat an herbivore in a habitat. The 1-tooth immigrant and 3-teeth carnivores have no P DNA, and the 5-tooth carnivore has one **P** DNA. The 5-tooth carnivore wins the physiology contest, so the others starve.*

HUSKERS are animals adapted to crack the husk of mast and obtain the high energy contents within. The dominant huskers are rodents, sparrows, and pigeons. A uniquely American rodent husker is the squirrel, which has co-evolved alongside acorns, beechnuts, chestnuts, etc. Such mast trees find the squirrels useful to disperse their seeds, not all of which are subsequently eaten after being squirreled away. In competition for the services of squirrels, many American trees have made their seeds as thin-skinned and squirrel-sized as possible. This is in sharp contrast to other continents that have no squirrels. For instance, South America and Australia have heavily-armored nuts (Brazils & Macadamias), and squirrels introduced there die out. Within the last million years or so the team of squirrels and the trees that host them have successfully invaded places like Europe and Brazil.

VEGETARIAN DIGESTION. Most of the energy of a leaf is locked up in cellulose, the most common component of fiber. No known animal can digest it without employing legions of bacteria in elongated digestive tracts. These tracts include the *hindgut* (colon or intestine) and the *foregut* (stomach or crop). The hindgut "fermentation" digesters include elephants, rhinos, hippos, horses, and extinct sloths, ankylosaurs, and pachycephalosaurs. A large amount of foliage can be processed rapidly in the hindgut, but the droppings will contain much undigested food. Elephants spend 77% of their time eating because of digestive inefficiency. The "ruminating" foregut digestors are more efficient because the vegetation in the crop can be regurgitated forward for additional processing and mastication. Such "cud-chewers", such as deer, giraffe, camels, goats, bison, and cattle, are often smaller than the foregut digesters. ***The Dinosaur Heresies**, by Bob Bakker (1986)*

**Arctic immigrants in the game invade from Asia over the Beringia land bridge. Jet Stream immigrants invade from Europe over the Thule land bridge. And tropical immigrants invade from South America over Panama or Gaarlandia.*

***Because it is vastly easier to digest meat than vegetation, predators don't require dental batteries for mastication and food processing. They require only minimal dentition to subdue their prey.*

15.0 GREENHOUSE

A red disk in the chart on the west map edge monitors the Earth's Greenhouse Level. The higher the level, the hotter the climate. The Greenhouse can end the game, see 18.0c.

15.1 Greenhouse Habitat Displacement.

During global warming, the greenhouse level disk goes up one step, and the habitats displace north to stay cool. During global cooling, the disk goes down and the habitats move south to stay warm.

a. Habitat Displacement. If the greenhouse rises, move every habitat (including its biome, and all its animals and immigrants) north to the slot directly above. (Its best to start with the most northerly biomes.) If the greenhouse falls, move every habitat south to the slot directly below. If it cannot move because it is at the map's edge, it remains where it is.

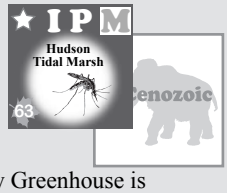
***Exceptions**: Orogeny biomes (2.4e) and super-ferns (6.1f) do not displace during greenhouse events. The biome directly north or south will displace into its slot, and then the lower-climax biome goes extinct.*

***Note**: Farms (9.2e) displace with their homeland.*

b. Biome Competition. If after the habitats are displaced, two biomes are stacked together, the lower climax biome goes to the tarpit. The animals on the extinct biome also are lost, unless they can live in the winning biome.

c. Melting of the Ice-Caps. If the Greenhouse moves into the 3200 ppm spot, each biome marked with a blue star is flipped after it is displaced, now representing a barren *sea biome*. If the greenhouse drops from 3200 ppm, flip each back to its face-up side.

d. Ice-Cap Formation. If the Greenhouse moves into the 200 ppm spot, each biome marked with a white star is flipped after it is displaced, now representing an *ice habitat* (11.1d). If the greenhouse rises from 200 ppm, flip each back to its face-up side.

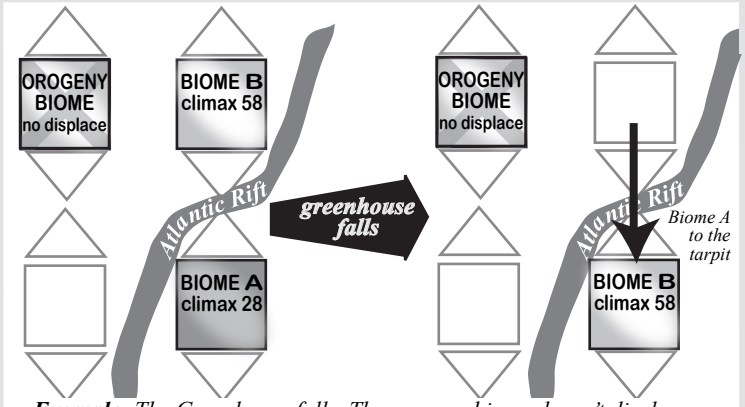


e. Inverted Biomes. A biome inverted by a high or low Greenhouse is uninhabitable (and, in the case of low Greenhouse, impassible to flightless animals as well). It is considered to have a climax of 100 plus its original climax. For instance, climax 63 goes to 163.

15.2 Empty Slots.

a. Archipelago. If the Greenhouse disk is at 1600 ppm or higher, then empty biome slots are seas (because of flooding from ice-cap melting).

b. Continent. If the Greenhouse disk is at 800 ppm or lower, then empty biome slots are land (because of low sea levels).



***Example**: The Greenhouse falls. The orogeny biome doesn't displace. Biome A also doesn't displace, since it is at the edge of the map. Biome B moves south on top of Biome A. Since Biome A has the smaller climax, it goes extinct. Note that if the Atlantic Ocean has formed, Biome B would be blocked from displacing, and nothing would move.*

16.0 EXTINCTIONS

16.1 Extinction of Biomes or Immigrants.

a. Tarpit. If a biome or immigrant is removed from the map (as a result of a catastrophe or culling), put its tile into the **tarpit** area of the map.

16.2 Extinction of Player Species.

a. Stack Cards and Tiles of Extinct Species. Any species without map animals is **extinct**. Discard the mutation cards in its stack out of the game. If there are any genotype cards in its stack, put them into your fossil record. Return its inheritance tiles to your reserves. If all species of a Color are extinct, see 16.3.

b. Animals of Extinct Species. Return all map, size, roadrunner, and culture animals to your reserves.

16.3 Lazarus Player.*

If your last species goes extinct, so you have no map or size animals, continue to play as a "Lazarus" player. If you purchase a card, you must either use it for *resurrection* (see below) or discard it. Furthermore, you cannot collect tarpit tiles during *scoring* (4.4d).

a. Raising from the Dead. As a Lazarus player, you may perform a special **resurrection action** by buying a mutation card per 5.0, using it to mutate any of your four species per 7.1, and placing a map animal of that species anywhere on the map where it can survive. Set your *size animal* at any desired size within the limits of the card, and set a *roadrunner animal* if the mutation card includes roadrunner DNA. Once resurrected, you are no longer a Lazarus.

17.0 EPISODES

17.1 Atlantic Rift.

Right after the first *Catastrophe event* of the game is resolved (6.2), remove the *Atlantic Rift Disk* (3.9a) on the ammonite to indicate the creation of the Atlantic Ocean. This ocean, shown as a dark blue valley on the map, forms a barrier that can't be crossed except by sea animals (those having 2 or 3 marine (**M**) DNA). Not even *amphibians* (only 1 **M** DNA) or *flying animals* (**SSS** DNA) can cross. This barrier is treated as the edge of the map during *Greenhouse shifts* (15.1a).

***Note (currents):** A sea animal pays no extra movement cost to cross the Atlantic. See the movement example on page 6.*

***Important**: Since immigrants can invade from the west or east, they can appear on either side of the Atlantic (6.1g).*

***Example:** A volcano raises the greenhouse on a turn after the Atlantic has formed. Biomes in the furthest east slots in the arctic and horse latitudes do not displace because they are at the edge of the map.*

17.2 Current Era.

Right after the second *Catastrophe event* of the game is resolved (6.2), remove the *Era Disk* (3.9a) from the sunflower, changing the **era** from **Mesozoic** to **Cenozoic**. The remainder of the game will introduce Cenozoic rather than Mesozoic *era tiles* (see 6.1a and 6.2b).

18.0 ENDING THE GAME

The game ends at the end of the turn during which one of the following happens:

a. The last Period Deck (the Tertiary, see 3.8) runs out of cards.

b. Either the Mesozoic or Cenozoic Era Pool runs out of *era tiles. This triggers a final scoring round (4.4).*

***Optional**: If the Mesozoic Era Pool runs out, start drawing from the Cenozoic.*

c. The Greenhouse goes to Snowball Earth or Hothouse Earth (see map).

***Note**: The game continues even if all players have lost their populations.*

GREENHOUSE LEVEL is measured in parts per million (ppm) of atmospheric carbon dioxide by volume. High levels trap solar heat, melting the icecaps and rising sea levels. Low levels cause global cooling and ice-cap formation. The Permian Catastrophe rocketed greenhouse levels from a 250 ppm ice age to an 1800 ppm hothouse, a temperature rise of about 10°C. Greenhouse levels soared over 2500 ppm during the late Mesozoic Era, but have been falling ever since. This decline, caused in part to the formation and erosion of the Tibetan plateau, has led to today's ice age, which oscillates between a 280 ppm deep freeze and a 400 ppm interglacial. For the last 15,000 years, the climate has been climbing out of the last deep freeze. Today's value is 388 ppm, and if it follows the last dozen cycles, it will peak at 400 ppm before falling into the next deep freeze. The situation is like a brisk September morning. In the short run it will get hotter as midday approaches, yet over the longer run it will get colder as winter sets in. Today's air is so impoverished in CO_2 that plants struggle to breathe, having been adapted to levels many times higher throughout most of Earth's history.

SEA LEVELS were close to present levels at the start of this game, covering a shallow continental shelf off Pangaean shores. They rose dramatically during the Jurassic, inundating the Midwest and separating America into east and west ranges by the Cretaceous. They dropped again during the Cenozoic. The formation of ice-caps during the Pleistocene dropped levels 130 meters below present, exposing bridges to Asia and Greenland.

"In any non-self running simulation, there must be Lamarckian appeals." Mike Wasson of Fat Messiah Games

**LAZARUS SPECIES are creatures missing from the fossil record for many millions of years before mysteriously "rising from the dead". This is an observational artifact caused by incomplete fossil records.*