Tree Frog Mutations

Most scientists will agree that there are two main factors that have influenced the evolution of biological organisms; they are common descent with modification and natural selection. Mutations are considered to be the raw materials for natural selection which can lead to evolutionary change among living organisms. Mutations can be defined as a permanent change to the genetic makeup of an organism. In other words, they change or alter the base sequences of DNA or RNA, which are the crucial components to the formation and development of all cellular forms of life (Mutations n.d.). Many of the differences among organisms arise due to the theory of natural selection, which is the notion where less favorable changes are removed from the gene pool while more beneficial modifications thrive. This report will outline how components of the biosphere and the geosphere are confounding factors to the development of biological organisms throughout Earth’s history. More specifically, it will compare and contrast the reproduction, development, and survival of amphibians and how environmental and biological components have and are influenced by evolutionary change. An example of this might be the comparison between two members of one particular species of amphibians.

When observing the genus Hyla, or tree frog, species, scientists can examine how environmental and biological factors have impacted these specific organisms. Affiliates of the Hylidae family have been active members of the Earth’s biosphere for more than 200 million years as well they have been a vital linkage in the food chain and have developed close bonds with the environment (Hunt 1995). In fact, the reproduction, development, and survival of the Hyla species can advise much about the stature of the
planet’s ecosystem. Moreover, alterations in the genetic makeup of the Hylidae family can impact the biotic community, either constructively or destructively.

In order to gain insight on how amphibians, such as frogs, are indicators of the environment, one must understand how a typical frog reproduces, develops, and interacts with it in connection with evolutionary change. Amphibians are ectothermal vertebrates; they have a backbone and the ability to maintain homeostasis to adapt to their surroundings. They are sensitive to various temperatures and humidity and require moisture and water throughout their development from fresh or slightly saline water (Hunt 1995). For this reason, they choose their habitat based on climate, rainfall, and topography all of which are required to meet the basic needs for pliable life structure. Most often, they can be located around swamps and marshes, but sometimes inhabit arid areas like the desert. When faced with dry conditions, some amphibians rely on specialized modifications. For instance, members of the Hylidae family that inhabit the desert bury themselves underground and create water-impervious cocoons and hibernate until rainfall when they can breed in a temporary pond (Frog n.d.).

In addition, frogs are thin-skinned organisms and are semi-aquatic, meaning they inhabit both land and water. One of the most important features of a normal frog is that it is composed of highly permeable membranous skin. This adaptive characteristic assists the lungs with breathing so that the frog absorbs oxygen and water through an aqueous film that allows nutrients to pass through blood vessels and enter into the bloodstream (Frog n.d.). Although the skin has evolved to absorb nutrients like water and oxygen, it can also make the organism susceptible to toxins within the atmosphere, hydrosphere,
and soil, which can result in a decline of the Hylidae family and significantly impact the planet’s ecosystem.

An important factor to consider is that environmental conditions, such as temperature, topography, and water supply, must be viable in the reproduction and development of members of the Hylidae family. Reproduction and development of the Hylidae family has been extensively researched and studied by evolutionary biologists. Mating usually occurs in spring or during periods of rainfall for different geographical areas. Ordinary male frogs will claim territory near a body of water and call out during the night, or croak, for female suitors. Once they have arrived, male of the genus Hyla will hop on the dorsal side of the female and grab hold of her tightly through a process called amplexus (Hunt 1995). Female amphibians will lay from one to several thousand eggs in a season. The male will deposit sperm on top of the eggs to fertilize them. Once the eggs have been fertilized, most “r-selected” females and males will leave the breeding site and carry on with life as usual. Anywhere from 36 to 48 hours, an egg laid in water can develop into a tadpole, which will spend the next few days competing with others for food and attempting to avoid predation. Rather quickly, the tadpole undergoes a change in its form known as metamorphosis and develops into a froglet, which is a tailed frog. Afterwards, a frog develops and continues to rapidly grow for about two years and then it slows down considerably.

A common species of frog is considered to be the arboreal frog, which can be found throughout North and South Americas, Europe, and northern Africa (Hulse et al 2001). Any disturbance or change in the genetic makeup and/or environment can affect the tree frog significantly. As mentioned previously, a frog’s skin is essential to its
ability to absorb oxygen and water. As well, a tree-frog’s covering can prove to be extremely vital in reproduction and survival in the environment. Typical arboreal frogs use their epidermis layer to blend into their habitat and surroundings. Through natural selection, tree frogs have developed pigment cells that aid in altering their skin color. This adaptive characteristic can be advantageous in defending themselves and warning predators if they are poisonous. In addition, a tree frog’s skin can absorb or reflect sunlight and heat energy, identify itself in order to establish a territory, and attract a mate for producing offspring (Manning n.d.). If a member of the genus Hyla does not develop adaptive pigment cells but rather acquires a mutated form of the amino acid tyrosine, they will lack the proper melanic pigmentation to adapt to their surroundings. In other words, these amphibians have inherited a less favorable characteristic which can be considered a mutation in the genes inherited.

An albino tree-frog lacks the capacity for the three types of pigment cells, called chromataphores, to work together. According to Corey Binns, in a normal skin cell the chromatophores are stacked upon one another. The melanophores compose the bottom layer and are responsible for producing the melanin, or pigment coloration. The iridophores are the middle layer and assist with the reflection of light and heat energy. This is how amphibians portray a silvery, iridescent reflection. When sunlight penetrates this layer, it reflects a blue-like coloring. Finally the top layer is called xanthophores, which contains yellowish pigments. In this layer, light is reflected once again and produces the green coloring that humans can observe (2006). The inability for the chromatophores to work together results in defective skin cells and produces an organism that lacks the capacity to blend in its environment and ineffectively absorb and reflect
light and heat energy. Consequently, this makes albino tree frogs more susceptible to predators, inefficient at obtaining oxygen and water, and incapable of maintaining homeostasis.

Albinism can also affect the vision of the mutated organism. A lack of pigment in the cells can arise in the retina in the eyes. This causes organisms to have red eyes as well as deficiency in protection against light-induced injury and impaired vision. Most arboreal frogs possess the ability to see prey and predators from three to ten feet away (Hunt 1995). Yet, an albino frog may have difficulty escaping predation or acquiring food due to vision sensitivity.

By claiming a territory of its own, a typical frog has ensured an adequate food supply and a safe place to breed. This may prove difficult for an albino tree frog. Like other animals, frogs will attack and fight for their own territory. Due to biological and environmental conditions, some albino tree frogs may have a difficult time in battle and become unable to gain a safe place to eat and mate. In addition, territorial domain ensures breeding and the notion of “survival of the fittest.” Isolation can play a major role in the survival of an organism as well. Due to its unusual appearance, an albino tree frog is often rejected by mates and others of the same species. Male organisms tend to be more colorful and use this characteristic to attract female mates of the same species. Since albinos lack the necessary coloration, they could not beat out the competition and become unable to produce offspring; therefore, making them “unfit” (Lamere 2006). Whether normal or mutated, amphibians have been impacted by and affect both biological and environmental causes.
Frogs can be good indicators of the environment and can disclose a lot of information about the health of an ecosystem. Because of their intermediate position in the food chain, scientists are able to analyze predator/prey relationships among various organisms. In addition, skin permeability and biphasic life of frogs reveals the health of an ecosystem. Through observation of different Hylidae populations in their own habitat, scientists can assess levels of pollution/toxins and climate change in the environment based on the confounding factors listed above. Moreover, researchers have discovered a dramatic decline of frog populations. Since the 1950s, one third of populations have been threatened with extinction and removal from the planet’s ecosystems (Frog n.d.). Habitat losses, pollution, climate change, the introduction of non-indigenous predators/competitors, emerging infectious disease, human impact, and alterations in the genetic makeup of organisms have all contributed to this decline.

Some other favorable ways that biological and environmental factors coincide to impact evolutionary change among the Hylidae family can be described through adaptations in response to ecological change. Normal members of the arboreal species have developed strong, muscular hind legs with a web of skin between the toes in order to climb and leap tree limbs and branches in search of food and as a means of defense or escape from predators (Hunt 1995). Hence, if a frog’s genes did not code for this trait, then it would be susceptible to decline. Another example of this relationship would be the genetic adaptations of some frog species that secrete poisons through their membranous skin. Again, this defense mechanism is in response to survival; however, some other species of animal have adapted, through natural selection, to the secretions and remain unaffected. Furthermore, frogs inhabit both parts of the hydrosphere and the
geosphere and are able to gain essential nutrients for biosynthesis of enzymes and amino acids from both as well as through the atmosphere by means of their adapted lungs and permeable skin. Therefore, chromosomal mutations for skin may contribute to early termination of the organism. A final example of the relationship between the environment and biological components is that frogs need the hydrosphere for breeding, which ensures survival of the fittest. A frog unable to reproduce due to the ineffectiveness to attract a mate and/ or the area of where it chooses to breed does not ensure its continuing life cycle. More specifically, some species breed in cooler temperatures because the dissolved oxygen is at a higher level, which aids in tadpole development (Frog n.d.). If a frog does not develop the essential correlating chromatophores within the skin cells, it is unable to maintain homeostasis and will inevitably diminish.

In summary, this report outlined how components of the biosphere and the geosphere are confounding factors to the development of organisms and it discussed how environmental and biological components have and are influenced by evolutionary change of amphibians, specifically arboreal frogs. It encompassed the role each has played on reproduction, development, and survival of these organisms in the planet’s ecosystems. In addition, it compared and contrasted the differences between a normal arboreal frog and an albino tree frog. In conclusion, when examining any species within an environment, it is important to research all factors that may influence or be affected by it, whether they are biological or ecological.

References


