

Plant and animal interactions in the tropical rainforest



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Why are animal-plant interactions considered important in the establishment and maintenance of high biodiversity in tropical rain forests? Include specific examples in your answer.

The study of plant-animal interactions has been a key role in development of ecology hence it has been carried out for a long time. They are also key constituents of biodiversity, which is termed as a variation of life form in a particular ecosystem. Hence, with no diversity of antagonistic, mutualistic, comensalistic, and amensalistic interactions, ecosystems would simply stop functioning. Energy would not run between trophic levels, primary productivity would not be able to become secondary productivity, and inorganic nutrients would not rotate. Because species interactions are thought to be at the heart of many speciation events, they generate taxonomic and genetic diversity with tight and diffuse co-evolution (Waser and Ollerton 2006).

Biodiversity is described as a response to dynamic processes such as ecological, evolutionary and physical, influenced by constant changes in time and space. Those changes consider species richness and their composition where the scale of them can take a variety of forms. They can be large such as changes in geological time of tectonic plates (Crame 2001), variable such as global climate change or small such as localized disturbance or heterogeneity (Jansen 1997). At each of these scales, biodiversity may be considered as a process that responds to biotic and abiotic factors rather than to static characteristics of a particular location. Biotic factors can singly or in combination, directly or indirectly change biological diversity in tropical ecosystems. Using different examples across plant and animal taxa I will

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highlight plant- animal interactions that cause changes, as well as establish and maintain biodiversity within a rainforest.

While studies concentrating on ecology and evolution are thought of dynamic processes, their impact into effects of biodiversity conservation has been subject to debate. In general, many conservation attempts have concentrated on protecting particular areas, habitats and hotspots. For instance, biodiversity in Yellowstone National Park varies greatly because of re-introduction of wolves. On the other hand, the conservation of the park from location and/or habitat point of view has not altered. This suggests that (1) biotic interactions are the main reason for biological diversity; (2) biotic interactions may be direct or indirect (Letourneau and Dyer 2005); and (3) biodiversity and biotic interactions may result in a variety of causes and effects.

For centuries, scientists have studied the functions of top-down (predator-dependent) and bottom-up (resource-dependent) regulations in structuring biological communities. The concept of trophic cascades engages indirect outcomes of top-down and bottom-up regulations, i. e. an alteration across one trophic level which indicates an alteration on a remote trophic level. Indirect outcomes involve modifications in biomass, abundance, efficiency or biotic diversity. Trophic cascade hypothesis was first described by Hairston et al. (1960) who stated that ' the world is green' due to predation which regulates herbivores, hence, making productivity of higher plants found in the community more efficient. Even though first research concentrated on community structures across terrestrial habitation, other studies are driven toward establishing freshwater and marine ecosystems constituents and <https://assignbuster.com/plant-and-animal-interactions-in-the-tropical-rainforest/>

cascade outcomes found in there (Brett and Goldman 1996). A study performed by van Bael et al. (2003), which concentrated on a terrestrial habitat, illustrated that bird predation protected rainforest trees from arthropod foraging in the canopy where floral productivity was high. The above findings may be a great indicator of high diversity occurring in the tropics; nonetheless, the meaning of how important top-down and bottom-up trophic cascades are is still a subject of a debate.

Nowadays research have concentrated on the way top-down and bottom-up trophic cascades can function in concern to structure community, change over space, time and taxa, influence mechanisms and constituents of complex food webs and maintain heterogeneity and biodiversity in complex ecosystems (Letourneau and Dyer 2005). Any fluctuations in tropics biodiversity can be maintained by a variety of direct trophic interactions. For instance, the species diversity of birds as predators can be dependent on food accessibility for their prey e. g. plants (German and Chacon de Ulloa 1997), or diversity of predatory arthropods can be shaped by herbivore diversity, which in turn is caused by plant abundance and diversity in a given habitat (Saiz et al. 2000).

All ecosystems are retained by the interactions of various factors such as climatic changes, vegetation growth and the animals' activities. Seed dispersal is one of the most significant processes, influencing the structure and dynamics of the entire plant and animal communities. Biotic interactions in relation to seed dispersal and associated with it species are next to be discussed.

Many organisms contribute and provide a unique seed dispersal service in rain forests among which primates, birds, fruit bats, mammalian carnivores and ground-dwelling large herbivores play a crucial role. Primates may contribute in multiple ways to the ecology of tropical rain forests. One of it, as mentioned above, is being a seed dispersal agent, hence being a frugivore. According to Chapman and Onderdonk (1998), the eventual loss of a particular plant species (large, with large seeds and thick, inedible hunks which can be only removed using hands or teeth) may be associated with the decline or local extinction of primates. A typical seed dispersal done by primates involves dropping, spitting out or defecating seeds. Because seeds are generally hard to break and usually toxic, there is a tiny minority of primates that is able to destroy them completely. From a seed point of view it is not a good idea to end up directly under the fruiting tree where it has to compete with its siblings and parent. Also the accumulation of pests and diseases in there is higher. This is when primates, yet again, serve as helpers by dropping or spitting out seeds in different locations. There are numerous factors contributing and subtracting to seed dispersal when consider primates defecation. In overall, the main ones include attractiveness of primate faeces to seed-predating rodents and the abundance of faeces-burying dung beetles (Andresen 2002; Feer and Forget 2002).

Whereas primates are very important seed dispersal agents for large plants, birds play a significant role in dispersal of plants with small fruits. Birds seem to be especially important in New Guinea and Australia (Jones and Crome 1990) where a lack of frugivorous mammals is the main threat. In general birds are not for long in the fruiting tree. Before they void the seed they

usually move to another tree hence they disperse the seed effectively (Green 1993). For this reason they are considered to be one of the most important seed dispersal agents across tropics. Furthermore, fruit-eating birds may be divided depending on their diet. The more generalist feeders visit more trees. They have, therefore, the potential to be capable of wider dispersal (Green 1993). The cassowary is perhaps one of the crucial seed disperser of local rainforests. Until recently, over 200 rainforest plants have been observed to be eaten by this bird (Kroon and Westcott 2001). One study discovered 78 species in cassowary faeces, with at least 70 of them being viable (Stocker and Irvine 1983). Many of the seeds appear undamaged and many of these are too large for other animals to disperse (Stocker and Irvine 1983). Although the bird itself is hard to see, its faeces can be common and prominent, and can have up to 1 kg of seeds (Stocker and Irvine 1983). Also, as a large animal, it has the potential to be efficient seed dispersal agents over larger distances. Thanks to radio-telemetry it was possible to show that cassowaries cover vast territories, sometimes of several kilometres, which may be done in one day (Kroon and Westcott 2001). Additionally, seeds can take more than 10 hours to pass the digestive system (Stocker and Irvine 1983), hence seeds are likely to be dispersed quite widely.

Primates and large birds are great seed dispersal agents. As a result of that spatial distribution trees may increase greatly. A research suggests that tree distribution in the tropics depends on species' methods of seed dispersal. The study by Seidler and Plotkin (2006) was done on 561 tree species in a lowland tropical forest in Malaysia. It was observed that trees with smaller

fruit were less dispersed than trees with larger fruit. This may suggest that larger-bodied mammals and birds transmit the seeds of these tree species over larger distances.

Bats are thought of less important but still meaningful seed dispersers. It could be said, they are wasteful as seed dispersal agents, because of depositing most seeds from the fruits they eat right near the angiosperms. Hence, the most successful seeds, in this case, would be the smallest ones as they can be swallowed and defecated or dropped during the flight. On the other hand, bats are crucial for the pioneer shrubs and trees that are abundant in natural or human-made clearings, mainly localised in Neotropics. Recent studies by Melo and colleagues (2009) suggests that small-bodied bats (*Artibeus watsoni*) inhabiting Neotropics are assumed to play a negligible role in the dispersal of large-seeded plants. They recorded at least 43 seed species around bat roosts and also suggested the pattern of species-specific abundance of seeds which influences seedling recruitment. These small frugivorous bats are especially important in regions where populations of large-bodied seed dispersers have been reduced or exterminated by hunting (Melo et al. 2009). Another example is a fruit bat (Chiroptera: Pteropodidae) localised in a lowland Malayan rain forest. The study performed by Hodgkison and colleagues (2003) suggests that fruit bats did not have negative influence on seed viability. Further, they found that in 1 ha of old-growth forest 13.7 percent of trees at least in part depended on fruit bats for seed dispersal and/or pollination (Hodgkison 2003).

Rat-kangaroos (*Hypsiprymnodon moschatus*) studied by Dennis (2003) are believed to be good seed dispersal agents in Australian tropical forests. They were found to perform similar behaviour to agoutis, acouchies and squirrels found elsewhere. Even though they are the smallest known marsupials they are still able to disperse large numbers of fruits and seeds which can be done in two unique ways: 1) by scatter-hoarding or 2) by dropping elsewhere.

Another important factor influencing great biodiversity in the tropics is pollination. It has been known for a very long time and was first described by Sprengel in 1793. Rain forest pollination, on the other hand, was first studied in the Neotropics (Roubik 1978; Bawa et al. 1985) where the most important pollinators were found to be bees, diverse insects and hummingbirds. They are excellent pollinators and a vast part of angiosperm diversity can be a result of their co-evolution. However, species such as bats, wasps, lemurs and even lizards are also vital pollinators. Studies performed by Corlett (2003) in the Oriental (Indomalayan) region suggest that, although these lowland forests are much less studied and known, they still express similar patterns as the Neotropics. He found out that large solitary bees, moths, butterflies and vertebrates are less meaningful as pollinators than extremely social bees (especially *Trigona* and *Apis* species) and beetles (most likely to be the next crucial group).

A study performed by Goulson and Derwent (2004), however, indicates that to be a pollinator does not necessarily mean to be beneficial to the ecosystem. They illustrated an example of an exotic weed, *Lantana camara*, and associated with it an exotic honeybee, *Apis mellifera*, inhabiting

Queensland, Australia. This interaction, even though causing higher
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biodiversity across tropics, may equally bring losses and environmental degradation. Goulson and Derwent (2004) also pointed out that *A. mellifera* are possibly pollinators of many other weeds, both in Australia and elsewhere.

Muchhala and colleagues (2009) studied impact of bats and birds on a flowering plant, *Aphelandra acanthus*, and its pollination. They observed that hummingbirds and bats could be compared in a case of pollination 'quantity' whilst bats were the most effective in a case of 'quality'. It was suggested that approximately 70 percent of *A. acanthus* was pollinated by bats themselves and since there is known 170 species of this genus the result is pretty impressive. This indicates that these angiosperms depend on bats' pollination to a high degree.

Another study carried out by Roubik (2000) shows that African honeybees, *Apis mellifera*, were the first exotic bees to invade Neotropics, where they interacted directly with approximately one-fourth of the floral population. These findings indicate that honeybees are a great indicator of a biodiversity formation and maintenance. By interacting with so many plants it can be predicted that the diversity of plant species may be easily preserved and upheld.

Since plants and their pollinators are often in co-evolutionary mutualism, many research suggest that some insect species are associated and restricted to a particular plant species. Hence, there is yet another argument demonstrating that the biodiversity in tropics must be high in order to preserve all the co-evolving organisms. For this reason, some organisms

relay on their mutualistic partners in order to survive. On the other hand, research proposed by Novotny and Basset (2005) suggests that a majority of species in herbivore populations found within tropics do not feed on a single species of plants when alternative hosts are accessible. Consequently, limits of host plants are likely to match with those of plant genera, rather than species or taxa. This illustrates an example that either way rain forests express high biodiversity and the way it is established.

Another aspect shaping biodiversity across tropics arises when pitcher plants (*Nepenthes gracilis*) and their interactions with infauna are taken into consideration. The aquatic environment created by pitchers is very beneficial for organisms inhabiting it such as aquatic insects including mosquito or fly larvae. The inhabitants of the pitchers were split by Thienemann (1932) into three separate groups depending on their appearance inside pitchers i. e. 1) occasional visitors which originally belong to a different place; 2) occasional visitors which may change environments continuously; and 3) native inhabitants. Therefore, since the pitchers are, in general, only partly filled with liquid i. e. up to the waxy zone, there is a 'terrestrial fauna' as well as an aquatic fauna (Lloyd 1942). Spiders, for instance, may take an advantage of pitchers by building nets above or nearby the plants therefore foraging at the expense of the pitchers. For aquatic infauna including protozoa, desmids and diatoms, rotatoria, crustaceae and various larvae of Diptera inhabiting the pitchers means food supply because they feed on animal detritus found in there (Lloyd 1942). Further, the pitchers interior environment is beneficial for many forms of Diptera larvae since they lay their eggs inside. In the fluid (always diluted by rain) the larvae grow to maturity (Bradshaw and Lounibos

1977). Alas, the environment may not be totally beneficial for these organisms since it is also inhabited by ants which in a case of absence of crucial nutrients tend to feed upon mosquito larvae (Clarke and Kitching 1995). Occurrence of ants as inhabitants of tropical pitchers may be, in turn, beneficial for both organisms. This thesis is supported by a study proposed by Clarke and Kitching (1995). They revised ant-pitcher interactions in Borneo and concluded that pitchers' habitat was great for ants to live in. The ants nested in the tendrils of the plant, and fed on the large prey items caught by the pitchers. Further, this relationship was also advantageous to pitchers because ants were removing an excess of prey which was accumulating inside the plant. This accumulation, if not removed, could lead to putrefaction of the contents and disruption of the pitcher's digestive system (Clarke and Kitching 1995).

Another study performed by Mogi and Yong (1991) proposed that aquatic arthropods, Diptera in particular, are able of coexistence in a single pitcher. Further, they stated that species belonging to the same trophic group commonly shared the same pitcher, because of the high occurrence probabilities of dominant species and positive associations between some taxa (mainly due to similar occupancies by pitcher age) (Mogi and Yong 1991). All these arguments may be a reasonable explanation why the abundance of species in pitchers followed by tropics is high.

Yet another mechanism that drives biodiversity in tropics is maintained by herbivores and the impact they have on plant diversity. So far, at least five hypotheses have been proposed. First thesis was suggested by Janzen (1970) and Connell (1971) who have stated that richness of plant species <https://assignbuster.com/plant-and-animal-interactions-in-the-tropical-rainforest/>

might be established by herbivores feeding on postdispersal seeds and seedlings near adult plants and lower level far away. With such a pattern, any plant species becoming abundant would be predated avoiding competitive elimination. Second theory was proposed by McNaughton in 1985. He hypothesized that ungulates that grazed on the canopy grass species in the Serengeti could reduce plant species competition. Following this idea, they would supply poorer competitors from the subcanopy with more resources, and, at the same time, they would diminish the loss of species through competitive elimination. Connell and Lowman (1989), who were authors of the third hypothesis, stated that deficient herbivore predation on the abundant species might lead to monospecific tropical forests. Langenheim and Stubblebine (1983) introduced the fourth thesis. They believed that in a case when herbivores would predate on certain conspecific chemical phenotypes seedling within this plant species might maintain nearby parent plants if they adequately vary in chemical profiles from their parent. In this way, predation could speed up competitive elimination in spite of Janzen-Connell idea about seed predation. On the other hand, it could also direct development of high genetic diversity within the aimed plant species. Fifth theory was announced by Connell in 1971. He stated that natural-enemy force (herbivores in this case) would be most successful. Also competitive elimination between plant species would be least expected in habitats with extremes of temperature and rainfall during the year i. e. lowland wet forests.

In all above examples, herbivores control local plant diversity by decreasing the possibility of species loss through competitive elimination. It is vital,

however, to think about the herbivores influence in a broader context.

Mechanisms by which they can manipulate plant diversity in rainforests are worth to consider. Herbivores and their influence on competitive interaction is just one such mechanism. As an alternative, herbivores can have a direct impact on the existence of a plant species in a particular site by diminishing its local richness or completely removing it, independent of its competitive capability. More-indirect outcomes contain three pathways. First, herbivores might establish if a species appears at a given location by having an impact on its dispersal ability, and hence the possibility that it might emerge there. Second, once a seed has emerged at a given location, herbivores can have an influence on the physiological ability of the plant to determine, nurture and breed regarding the abiotic effects occurring in there. Third, herbivores might have an impact on emergence of species in a given site by decreasing its competitive capability.

All in all, I believe I managed to introduce, explain and answer the topic question broadly. By introducing a selection of different examples I tried to cover many plant-animal interactions. That is why I can conclude that the tropical forests are a great habitat and environment for a variety of different species to coexist and co-evolve. Further, its favourable, warm, moisturised climate creates perfect developmental conditions for organisms to be able to persist and survive. However, one argument must not be omitted stating that tropical ecosystems may not be as biodiverse as previously thought (Novotny and Basset 2005). Hence, many comparisons between temporal and tropical zones should be taken into consideration to fully prove the idea. Nonetheless, from the number of organisms occurring within the tropics and

their interactions it is easy to conclude that plant-animal interactions are tremendously important in order to preserve life in there. Moreover, because of different trophic cascades and food webs biodiversity has to be maintained at an extremely high level so all organisms appearing in tropics will be able to stay alive.

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