

Evolution of size and its implication on climate change mitigation

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Introduction and objectives

Animal's size is a product of the selective pressures that act on them. This size is very important because it's one of the fundamental characteristics that determine animal-ecosystem relation. This project is an attempt to summarize our current knowledge of how animal mass evolves and how it indirectly affects the environment.

Size as a product of evolution

All species constantly adapt, evolve and proliferate in order to survive while pitted against ever-evolving opposing species [1]. This theory, known as the Red Queen hypothesis, is the key to understand gigantism.

Predators exert a mortiferous pressure on their preys and, consequently, these evolve to survive. One of the main responses of predation is increasing size. A bigger animal is more difficult to hunt and manipulate, therefore it can be advantageous to be bigger than the rest. However, as prey's population gets bigger, the smaller carnivores will have it more complicated to eat. As a result, increment in size will also be favourable for predators. Hence, a predator-prey positive feedback is created, promoting gigantism (Figure 1).

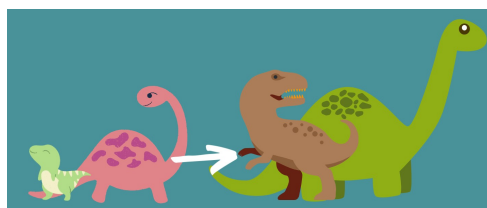


Fig 1. Gigantism predator-prey loop

Alternative responses to the gigantism predation-prey loop

The association of individuals acts as a break for this trend. Through reciprocal altruism, predators can achieve greater success. The same strategy goes for herbivores and gregarism.

Developing armour and weapons is another way to avoid being preyed upon by individuals of a higher ecological level.

Climate change mitigation by large animals

Large animals play a crucial role in mitigation of climate change in a global scale. Mainly, they act indirectly by modifying vegetation and ecosystems [2].

- a) Living organisms lower free carbon through primary and secondary production.
- b) Bog herbivores prevent fires by reducing vegetation biomass
- c) Animals generate multiple gases that interact with the atmosphere worsening climate change.
- d) Large animals modify important nutrient reservoirs by releasing these into the ecosystems.
- e) Through their influence on vegetation, big animals can increase albedo and therefore reduce surface temperature.
- f) By aiding at a dispersal of plants, animals contribute to the adaptation of biomes.
- g) Big animals shape their surroundings by creating microhabitats that increase resilience to climate change.

Linking the evolution and ecosystem functioning

Size is a product of evolution. A proper ecosystem functioning depends strongly on big fauna that modifies its biotic and abiotic factors. Therefore, these properties are an indirect result of evolutionary forces. Simpler ecosystems evolve into more complex ones owing to this predator-prey interaction through the geological times (Figure 2).

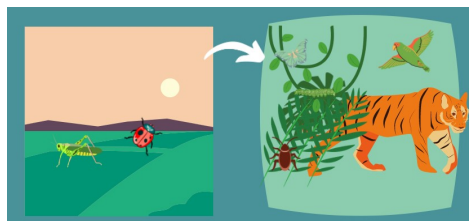


Fig 2. Evolution from simpler to more complex ecosystems.

When big fauna disappears, the whole community that was reigned by it breaks down into a simpler and more fragile ecosystem.

This is an actual problem, mainly due to human impact on the biosphere. Since humans started practicing agriculture and livestock, we have changed the distribution of large mammals on Earth [3] (Figure 3). Large wild animals have been replaced by domestic animals resulting in a redistribution of trophic compartments.

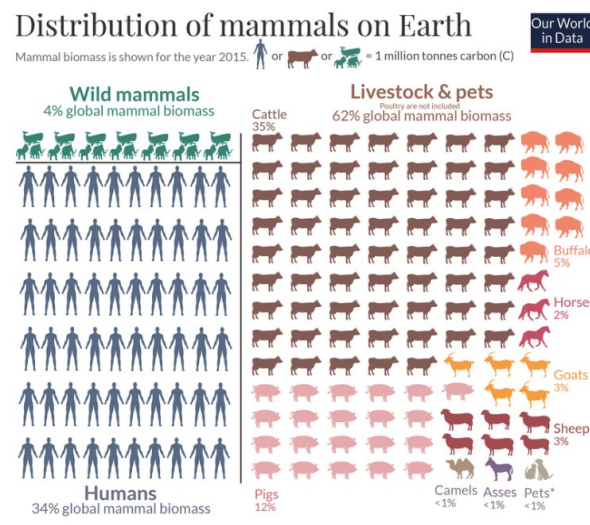


Fig 3. Distribution of mammals on Earth.

Source: Our World in Data

Conclusions

The constant adaptation of species in order to survive against opposing species has driven, in a geological time scale, to bigger animals. Large animals have a major impact on mitigation of climate change, principally by modifying vegetation and ecosystems.

Big animals act as, and therefore evolution brings about:

- 1) Keystone species that stabilize vegetation
- 2) top-down control of trophic networks by predators, which continue to become bigger as predicted by the Red Queen hypothesis.

Humans replace these large wild herbivores with domesticated herbivores. Hence, disarticulating ecosystems and worsening climate change.

As a conclusion, we see how evolution and ecology interplays to form the world that we know today, and how by disturbing these natural systems we are perturbing global ecosystems and well-functioning.

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