Biological Robustness and Biological Fragility

Robustness and fragility are fundamental features of biological systems. With increasing interest in biology, properties at the system level such as robustness or fragility have been attached great importance (Kitano, 2007). Numerous reports have been published on these two crucial characteristics. This essay will indicate the personal understanding of biological robustness and fragility.

First, there must be a common understanding on what “robustness” and “fragility” mean. From my perspective, biological robustness refers to the ability of an organism or a population to withstand stressors and disturbances and to continue functioning normally. Biological fragility refers to the susceptibility of a system or living organisms to unexpected and negative outcomes, such as collapse, disease, or death. These two colloquial definitions seem to be justified by several references. Kitano (2004) states that biological robustness is a property which makes a system to maintain its functions against internal and external perturbations. A similar definition of robustness is claimed by Stelling et al. (2004) that robustness is the ability to maintain performance in the face of perturbations and uncertainty. In addition, according to Sole and Montoya (2001), biological fragility is the sensitivity of an ecosystem to external disturbances at a given spatial and temporal scale.

Second, examples will make it easy to understand these two characteristics. One example of biological robustness is recovery, which is the capacity of an organism to restore or renew damaged tissue or cells, as in the case of a wound’s healing or the regeneration of a limb in some amphibian species. One example of biological fragility is that some plant or animal species which are restricted to specific geographic regions and are at risk of extinction due to changes in climate or land use.

Additionally, biological robustness can contribute to survival and it can be seen as the opposite of fragility. It is an integral part of survival because it enables organisms and populations to adapt to changing and unpredictable conditions and to persist in the face of environmental challenges. For instance, resilience, which is one of the manifestations of biological robustness, means populations that can quickly bounce back from disturbances, such as natural disasters, are more likely to survive and continue to thrive. Moreover, organisms that are able to adapt their behavior to changing circumstances, such as shifting food sources or changing predators, are more likely to survive. This is a type of behavioral flexibility and is also very applicable in human society. People who are able to behave accordingly and appropriately in different situations appear to be more likely to be established in contemporary

society, or at least not eliminated. If a species or an ecosystem has biological robustness, then it can better cope with various disturbances, and robustness can play a vital role in maintaining the stability and functioning of populations and ecosystems. Therefore, understanding and maintaining biological robustness is significant for ecosystem conservation and research in biologically related fields.

However, biological fragility, as the antithesis of biological robustness to a certain extent, is less friendly and less likely to play an active role because its consequences can be severe, and may include economic, social, and ecological instability, as well as loss of species life. For example, the death of individuals or populations will result in loss of biodiversity. Furthermore, biological fragility can also give rise to economic and social impacts. The loss in farming and animal husbandry, such as agricultural crops, can give birth to significant economic and social influences, and the loss of species important to cultural or religious beliefs can cause social unrest as well. To avoid biological fragility, one can adopt effective strategies including conserving biodiversity by protecting habitats, managing hunting, or trying to use resources sustainably. Simultaneously, since variable climate sometimes tends to cause severe climate damage to ecosystems and biodiversity, it is critical to reduce greenhouse gas emissions and adapt to the impacts of climate change.

In conclusion, it is essential to understand biological robustness and fragility since they are basic features of biological systems and robustness is integral part of survival while fragility will bring about negative effects on ecosystem, society and economy to some extent. Therefore, maintaining biological robustness and avoiding biological fragility is a topic worthy of further study.

(Word count: 700)

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