Biological Robustness and Fragility

The ability of organisms to tolerate environmental stress and change is described by two key biological concepts called biological robustness and fragility. In contrast to fragility, which is an organism's susceptibility to stress and change, robustness refers to an organism's capacity to preserve its integrity and function in the face of stress.

An example of robustness can be found in the tardigrade, a tiny aquatic animal that can survive extreme conditions such as extreme cold, heat, radiation, and even the vacuum of space (Ramm et al., 2014). Tardigrades have developed unique strategies such as the ability to enter a state of suspended animation, which allows them to survive in environments that would otherwise be inhospitable to life. On the other hand, an example of fragility can be seen in the monarch butterfly, which is heavily dependent on a specific plant species, the milkweed, for its survival (Oberhauser & Peterson, 2003). The monarch butterfly's lifecycle is closely tied to the availability of milkweed, and any changes in the availability of this plant can have a significant impact on the butterfly's population.

Biological robustness is a vital part of survival since it enables organisms to adapt and flourish in shifting circumstances. Robust organisms are more likely to survive and pass on their genetic makeup to succeeding generations. According to Bell and Koufopanou (1991), robustness is a key feature of living systems that allows them to cope with environmental perturbations and maintain their functions and integrity. Pigliucci (2001) adds that robustness also allows organisms to respond to environmental changes in a flexible way, and to adapt to new conditions and situations. This adaptation and flexibility ensure the species' survival and perpetuation and contribute to the conservation of biodiversity in ecosystems.

Fragility has serious negative effects since it can cause the extinction of species, which can have a knock-on effect on entire ecosystems. Due to its reliance on a single plant species, the monarch butterfly is vulnerable to changes in that species' availability, and any changes in milkweed's availability may have a large effect on the butterfly's population. Another example is that the extinction of the passenger pigeon had a significant impact on the ecosystem, as the loss of such a large number of birds affected the population of other species that relied on the passenger pigeon for food or pollination. Furthermore, fragility can also lead to the spread of disease. According to a study by Drake et al (2011), "Fragility can lead to increased susceptibility to diseases and parasites, which can lead to a decline in population size and increased mortality rates."

To avoid fragility, it's essential to understand the causes of fragility and take action to reduce them. Natural environment preservation and protection, pollution abatement, and invasive species management are some examples of this. In addition, conservation activities, such as breeding programs and the reintroduction of endangered species into the wild, can aid in the protection of fragile species. According to a study by Higgs et al (2018), "Conservation efforts can also help to maintain robustness by reducing the exposure of organisms to environmental stressors and maintaining the integrity of ecosystems." Moreover, it's significant to take steps to slow down climate change and its effects on species, as well as to take into account how climate change affects biological robustness and fragility.

In summary, biological robustness and fragility are crucial concepts in the area of biology that refer to an organism's capacity to tolerate stress and change in their environment. While fragile creatures are more susceptible to stress and environmental change, robust species can adapt to changing conditions and flourish in them. Understanding these ideas and taking action to reduce fragility can help protect vulnerable species and maintain ecosystem biodiversity.

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