International Journal of Super Species Research 2024, Vol.14, No.1, 1-7
http://ecoevopublisher.com/index.php/ijssr

Research Report Open Access

The Impact of Climate Change on the Coexistence and Competition of Super Species

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International Journal of Super Species Research, 2024, Vol.14, No.1 doi: 10.5376/ijssr.2024.14.0001
Received: 30 Oct., 2023
Accepted: 06 Dec., 2023
Published: 01 Jan., 2024

Preferred citation for this article:
Shan P., 2024, The impact of climate change on the coexistence and competition of super species, International Journal of Super Species Research, 14(1): 1-7 (doi: 10.5376/ijssr.2024.14.0001)

Abstract Climate change is one of the most serious environmental problems facing the world today, and its impact on ecosystems and species have become increasingly apparent. This study defines "super species" and analyzes their ecological characteristics as well as their importance in ecosystems. The article explores the major effects of climate change, including rising temperature, rising sea level, increased ocean acidification and extreme meteorological events, and how ecosystems respond to these changes. The specific effects of climate change on super species, including adaptive strategies, changes in migration patterns, remodeling of food chains and food webs, and the evolution of competitive and cooperative relationships. After examining the coexistence and competition of super species under climate change, we highlight the importance of ecological conservation and suggest the development of adaptive conservation measures and the need for international cooperation and policy initiatives. This study summarizes the effects of climate change on super species and prospects the direction of future research, aiming to provide a scientific basis for the ecosystem study of super species under climate change.

Keywords Climate change; Super species; Coexistence and competition; Ecological conservation; Adaptive strategies

Climate change is one of the important challenges facing the world today. With the rise in global temperatures, the increase in extreme weather events, and the rise in sea levels, climate change has had a profound impact on our planet. Scientists have proposed various catastrophic consequences of climate change, such as more frequent natural disasters, ecosystem collapse, and shortages of food and water resources (Fawzy et al., 2020). Therefore, understanding and responding to climate change is crucial.

In the process of addressing climate change, humans and other biological species are constantly adapting and evolving. A new concept has gradually attracted the attention of the scientific community and the public, which is the "super species". These species have excellent survival ability, can survive in extreme environments, and have relatively small impacts on climate change. The emergence of super species has raised many questions, such as whether they contribute to the stability of ecosystems and how they may affect the fate of other species (Dunayev et al., 2021).

This study aims to explore the impact of climate change on Earth's ecosystems and biodiversity, as well as the role of super species in this process. This study analyzes the direct and indirect impacts of climate change on ecosystems and biodiversity. How super species respond to climate change and their potential impacts on other species and ecosystems. Through in-depth research on climate change, super species, and ecosystems, and looking forward to future research directions, we can better understand and respond to the challenges of the current global climate crisis. This study aims to provide scientific basis for the study of ecosystems of super species under climate change.

1 Definition and Characteristics of Super Species

Super species are important biological groups in ecosystems, with a large number, strong adaptability, and diverse ecological roles, playing a crucial role in maintaining ecological balance, diversity, and ecosystem functions. Understanding and studying super species helps to gain a deeper understanding of the complexity and evolutionary mechanisms of ecosystems, providing important guidance for ecological protection and management.

1.1 Definition of super species

Super species is a biological population typically composed of a large number of individuals, possessing excellent survival and reproductive abilities, as well as a high degree of adaptability to diverse environments. These species typically play important ecological roles in ecosystems, including but not limited to predators, planters, or ecological engineers (Smutin et al., 2022). Super species have a profound impact on the ecological processes and biodiversity of ecosystems, characterized by a large number, strong adaptability, diverse ecological roles, and the ability to quickly adapt to environmental changes.

Polar bear can be seen as an example of a super species. Polar bears live in extremely cold polar environments, although they are not abundant, they occupy the top of the food chain and mainly feed on seals. They have extremely high adaptability, can hunt on extremely cold ice layers, and can tolerate extreme low temperatures. The presence of polar bears directly affects the structure of the Arctic ecosystem and the stability of the food chain, which is crucial for controlling the seal population and maintaining ecological balance in the Arctic (Figure 1).

Figure 1 Polar bears prey on seals

1.2 Ecological characteristics of super species

The number of super species usually significantly exceeds that of other species, with a large number of individuals. This feature makes them occupy an important position in the biomass of ecosystems and has a broad impact on ecological processes and material cycling. Super species exhibit strong competitiveness, as they can effectively compete for resources and limit the survival and reproduction of other species. Super species typically have diverse ecological roles, including predators, planters, pollinators, decomposers, and so on. This allows them to have a broader impact in the ecosystem, not limited to a specific ecological role. Super species typically have a high degree of adaptability, being able to quickly adapt to environmental changes and maintain the stability of their populations.

The ecological characteristics of super species include a large population, strong competitiveness, diverse ecological roles, and high adaptability. These characteristics make super species play a crucial role in the ecosystem, playing an important role in maintaining ecological balance, species diversity, and ecosystem stability.

1.3 The importance of coexistence and competition among super species

The competition among super species can maintain the stability of the ecosystem. Their presence helps to limit the excessive growth of certain species, thereby maintaining the diversity of ecosystems. Super species typically play a crucial role in maintaining ecosystem functionality. The adaptability and competitiveness of super species enhance the resistance of the entire ecosystem, making it better able to cope with environmental changes and disturbances (Berenbaum and Liao, 2019). They jointly shape the dynamic balance of ecosystems through competition, cooperation, and mutual constraints, providing important insights and guidance for the study of ecology and ecosystem management.

2 Main impacts of Climate Change

Climate change has a wide range of impacts on the Earth, including temperature rise, changes in precipitation patterns, sea level rise, ocean acidification, an increase in extreme weather events, and multifaceted responses in ecosystems. Addressing climate change is a shared responsibility of the global community, requiring comprehensive measures to mitigate its impacts and adapt to inevitable changes.

2.1 Temperature rise and changes in precipitation patterns

The continuous rise in global temperature is a significant feature of climate change. This trend has led to multiple impacts, including glacier melting, sea level rise, and frequent heat wave events. The increase in temperature also affects the distribution of plants and animals, driving significant changes in the ecosystem. Climate change leads to changes in precipitation patterns, including changes in precipitation, distribution, and seasonality. Some regions may face more precipitation, leading to problems such as floods and soil erosion, while others may become more arid, affecting agriculture and water supply. This has a broad impact on ecosystems and socio-economic development.

2.2 Sea level rise and ocean acidification

The global temperature rise has led to the melting of glaciers and ice sheets, which has led to a continuous rise in sea levels. Rising sea levels threaten coastal communities, leading to frequent coastal erosion, tsunamis, and floods (Figure 2) (He et al., 2019). Coastal ecosystems have also been damaged as seawater seeps inland, affecting freshwater ecosystems and coastal wetlands. The increase in carbon dioxide concentration in the atmosphere has led to the problem of ocean acidification. After absorbing carbon dioxide, seawater becomes more acidic, posing a threat to marine organisms, especially crustaceans such as coral reefs, shellfish, and plankton. Ocean acidification weakens their shells and bones, affecting the entire ocean food chain.

Figure 2 Disasters caused by floods

2.3 Increase in extreme meteorological events

Climate change has led to an increase in the frequency and intensity of extreme meteorological events (such as rainstorm, drought, hurricane and mountain fire) (Zhang et al., 2022). These events have caused serious damage to society, economy, and ecosystems. Excessive rainfall can lead to flooding, flooding low-lying areas, damaging infrastructure, and affecting public safety. The long-term drought conditions caused by climate change have prevented many farmland from being cultivated properly, reducing food production, leading to food shortages and rising food prices. Strong storms can trigger tsunamis, destroy coastal cities and port facilities, and cause large-scale casualties and economic losses. High temperatures and drought conditions make forests more prone to burning, and wildfires may quickly spread, threatening nearby communities and wildlife. Smoke and air pollution also have negative effects on people's health.

2.4 Climate change response in ecosystems

The increase in temperature and changes in precipitation patterns may lead to the migration of plant and animal populations to more adaptable areas. This may disrupt the existing ecological balance and affect biodiversity. Niche refers to the function and status of a species in an ecosystem. Climate change may lead to changes in ecological niches, with some species adapting to new ecological roles, while others may be under pressure (Fang et al., 2018). Some ecosystems are more vulnerable to climate change, such as coral reefs and polar ecosystems. They are more susceptible to pressure such as temperature rise and acidification, and may face greater extinction risks. Ecosystems provide many key ecosystem services, such as food supply, water resources, climate regulation, etc. Climate change may affect the delivery and quality of these ecosystem services.

3 The Impact of Climate Change on Super Species

The impact of climate change on super species is a complex and diverse process, and super species may exhibit various adaptive strategies, including migration, food selection, behavioral adjustment, and evolution. These changes may have profound impacts on ecosystems and pose challenges to human society and other biodiversity. Therefore, deeper research and protective measures are crucial for understanding and addressing the ecological impacts of climate change.

3.1 Adaptive strategies for super species

Climate change has forced super species to reassess their survival strategies. These species may exhibit diverse adaptive behaviors, including physiological adaptive changes and behavioral adaptive adjustments (Sideris, 2019). The Arctic fox is an animal considered a polar super species. As temperatures rise in the Arctic region, the distribution range of their main food source - seals - is also changing. The Arctic fox has demonstrated adaptive strategies, such as adjusting the breeding season to better match the migration season of seals. They also forage more frequently on land to compensate for the impact of reduced seal populations on their predation (Figure 3).

Figure 3 Arctic Fox Hunting

3.2 Changes in movement and migration patterns

As temperatures rise and ecosystems change, the migration patterns of super species may also change (Berenbaum and Liao, 2019). They may search for more suitable habitats, higher altitudes or farther latitudes. This migration may have significant impacts on ecosystems as they may interact with other species, triggering new competition and collaborative relationships. In Europe, colored butterflies are one of the widely studied species. Research has found that as temperatures rise, their distribution range shifts northward. In the past, they were mainly distributed in southern Europe, but now their appearance is becoming increasingly common in northern Europe. This change in migration patterns has potential impacts on the interrelationships between local ecosystems and other species.

3.3 Reconstruction of the food chain and food web

Climate change can alter species interrelationships in ecosystems, thereby reconstructing the food chain and food web. The number of certain super species may increase, leading to increased competition for their food resources, while other species may decrease or disappear (Fang et al., 2018). This may trigger a chain reaction and affect the

stability of the entire ecosystem. Climate change has led to the melting of Arctic ocean ice, affecting the entire ecosystem. Sea ice is the foundation of polar ecosystems, supporting multiple species such as plankton, benthic organisms, and whales. As sea ice decreases, the number of some benthic organisms increases, which may have a significant impact on the food chain of species such as whales and seabirds, thus reconstructing the entire food web.

3.4 Evolution of competition and collaboration relationships

The competition and collaborative relationships of super species may evolve due to climate change (Berenbaum and Liao, 2019). Some species may increase competition for resources as they become more scarce. On the other hand, certain species may establish new symbiotic or collaborative relationships to improve their chances of survival. Some plants rely on specific pollinators to spread their pollen, and pollinators also rely on the food resources provided by the plants. With climate change, the flowering time of plants and the activity time of pollinators may become out of sync. However, some plants and pollinators have shown adaptability, such as early or delayed flowering to synchronize with the activities of pollinators, thus maintaining a mutually beneficial symbiotic relationship between them.

4 Coexistence and Competition of Super Species under Climate Change

Climate change has had a wide and complex impact on the coexistence and competition of super species (Berenbaum and Liao, 2019). Their coexistence models, competitive pressures, and ecosystem stability have all undergone significant changes. Further research and monitoring are necessary to understand these complex interactions and take measures to promote ecosystem stability and protect biodiversity. At the same time, climate change also provides opportunities for some species to adapt and thrive, emphasizing the importance of ecosystem adaptability and resilience.

4.1 Changes in the coexistence model of super species

Under climate change, the coexistence model of super species may undergo significant changes. Originally, they may have been mutually exclusive super species, but due to changes in climate conditions, they may now coexist under certain ecological conditions. This situation may lead to the emergence of new species coexistence models, where some species may exhibit more competition, while others may achieve coexistence through collaborative adaptation. In the southern state of Florida, rising temperatures have led to an expansion of the habitat of the American alligator, while the distribution area of the North American gray wolf is also gradually expanding in North America. The coexistence models of these two species rarely intersected in the past, but now they have emerged in certain wetland areas in Florida. This example demonstrates that climate change may lead to species redefining their coexistence strategies in different ecological regions.

4.2 Evolution trends of competition and pressure

Climate change may also lead to competition and pressure evolution among super species. Some species may experience increased competition as resources become more limited. In some cases, this may lead to weaker species being pushed out by stronger ones. However, other species may exhibit adaptability, reduce competitive pressure, or seek new resources under new environmental conditions. This may lead to some species thriving in the new climate context, while others may be under pressure to reduce their numbers or disappear. In the Arctic region, climate change has led to a reduction in ice cover, which in turn has altered the distribution of plankton. Some plankton, such as crustaceans and phytoplankton, reproduce more due to higher temperatures and light conditions. This may lead to fierce competition as more species compete for limited nutrients and space, while also affecting species in the higher-order food chain such as Arctic whales.

4.3 Threats and opportunities to ecosystem stability

Climate change poses a threat and opportunity to ecosystem stability (Fang et al., 2018). Climate change may lead to species imbalance in ecosystems, with some species having excessive numbers while others have decreased numbers, which may affect the stability of ecosystems. Species that can adapt to new climate conditions and resource distribution may play a more important role in maintaining ecological balance in the ecosystem. This

adaptability may be achieved through evolution or through changes in ecological niches, such as changing food or habitat choices. These changes may provide new stable pathways for ecosystems.

The rise in ocean temperature caused by climate change poses a huge threat to coral reef ecosystems. Some coral species exhibit higher heat resistance, which can resist coral bleaching and death, giving them the opportunity to survive under new temperature conditions. The adaptability of these species may help maintain a certain degree of stability in coral reefs, although overall, climate change still poses a significant threat to these ecosystems.

5 Ecological Protection and Climate Change Response

5.1 The importance of protecting super species

Protecting super species is crucial for addressing climate change. Super species typically have high adaptability and survival ability, and can survive in different climatic conditions (Haight, 2018). They play a crucial role in the ecosystem, helping to maintain ecological balance and stability. Protecting these species helps to protect the entire ecosystem and mitigate the negative impacts of climate change on biodiversity. When facing climate change, some tree species such as Douglas fir exhibit high adaptability. Protecting these tree species helps to maintain the stability of forest ecosystems, promote forest growth and ecological functions.

5.2 Development of adaptive protection measures

In order to cope with climate change, it is necessary to develop a series of adaptive protection measures to help super species and other species adapt to new climate conditions. Protect and restore key habitats, ensuring that species have sufficient space and resources to adapt to climate change. Take measures to protect endangered and threatened species, including artificial breeding and reintroduction. Take management measures such as controlling invasive species, reducing pollution, and managing resources reasonably to enhance the resilience and adaptability of ecosystems. Protect and manage the genetic diversity of species to ensure their ability to adapt to new pressures caused by climate change. In the context of coral bleaching caused by global heatwaves, some countries have taken measures to establish coral protected areas, prohibit fishing and harmful activities, and improve the survival opportunities of corals.

5.3 International cooperation and policy initiatives

International cooperation and policy initiatives are crucial in ecological protection and climate change response. Countries around the world need to work together to develop and implement measures to mitigate climate change and adapt to its impacts. International agreements such as the Paris Agreement aim to reduce greenhouse gas emissions and control the pace of climate change. The international framework aims to protect global biodiversity, protect super species and other key species. Collaborative projects between international organizations, non-governmental organizations, and research institutions help to develop adaptive measures and share best practices. The Convention on Biological Diversity is an international framework aimed at protecting global biodiversity. Countries have signed conventions promising to take measures to protect species and habitats and address threats such as climate change.

6 Conclusion and Outlook

Climate change has a wide and profound impact on super species. These impacts include extreme weather events with increased frequency and intensity, changes in movement and migration patterns, reconstruction of food chains and webs, and evolution of competition and collaboration relationships. Super species typically exhibit adaptive strategies, such as adjusting breeding seasons, searching for new resources, establishing new collaborative relationships, or adapting to new climate conditions. However, climate change also threatens the survival of some species, which may lead to a decrease in their numbers or even extinction. This has had complex impacts on the stability and biodiversity of ecosystems.

Ecological protection plays a crucial role in addressing climate change. Protecting super species and other key species helps maintain the stability and functionality of ecosystems. This includes protecting habitats, implementing genetic diversity conservation measures, managing ecosystems and species, and developing international cooperation and policy initiatives. Ecological protection not only helps to adapt to climate change,

but also helps to mitigate climate change, as healthy ecosystems can act as carbon sinks and absorb large amounts of carbon dioxide.

Future research needs to focus on the following directions to better understand and respond to the impact of climate change on super species. Further in-depth research on how super species adapt to climate change, including physiological, behavioral, and evolutionary adaptation strategies. Conduct more research to develop more effective habitat management strategies to adapt to climate change and maintain ecosystem stability. Conduct in-depth research on the impact of climate change on competition and collaboration among species to understand changes and stability in ecosystems. Further strengthen international cooperation and develop more specific policies and plans to address the threat of climate change to biodiversity and super species. Education and stimulating public interest and participation in ecological conservation are crucial, as broad support and action can drive the success of conservation actions.

In short, the impact of climate change on super species is a complex and urgent issue. Through continuous scientific research, ecological protection measures, and global cooperation, we can better understand and respond to these impacts, ensuring that the biodiversity and ecosystems on Earth can adapt to and resist the challenges of climate change. This is a long-term mission that requires global cooperation and unremitting efforts.

References

Berenbaum M. R., and Liao L. H., 2019, Honey bees and environmental stress: toxicologic pathology of a superorganism, Toxicologic Pathology, 47(8): 1076-1081.
https://doi.org/10.1177/0192623319877154

Dunayev E. A., Solovyeva E. N., and Poyarkov N. A., 2021, Systematics, phylogeny, and evolution of phrynocephalus (superspecies *przewalskii*) (reptilia: agamidae), Russian Journal of Herpetology, 28(1): 43-59.
https://doi.org/10.30906/1026-2296-2021-28-1-43-59

Fang J. Y., Zhu J. L., and Shi Y., 2018, The responses of ecosystems to global warming, Kexue Tongbao (Chinese Science Bulletin), 63(2): 136-140.
https://doi.org/10.1360/N972017-00916

Fawzy S., Osman A. I., Doran J., and Rooney D. W., 2020, Strategies for mitigation of climate change: a review, Environmental Chemistry Letters, 18: 2069-2094.
https://doi.org/10.1007/s10311-020-01059-w

Haight K. L., 2018, Increased investment in the defence of high-value offspring by a superorganism, Animal Behaviour, 143: 59-66.
https://doi.org/10.1016/j.anbehav.2018.07.008

He Y. L., Ding L., Li D. D., Huang J. P., Li C. Y., and Bi L., 2019, Research review on the contrast of land and ocean warming features under the global warming, Ganhan Qixiang (Journal of Arid Meteorology), 37(5): 703-712.

Sideris L., 2019, The last biped standing? climate change and evolutionary exceptionalism at the Smithsonian hall of human origins, Journal for the Study of Religion, Nature and Culture, 13(4): 455-478.
https://doi.org/10.1558/jsrnc.39467

Smutin D., Lebedev E., Selitskiy M., Panyushev N., and Adonin L., 2022, Micro “bee” ota: honey bee normal microbiota as a part of superorganism, Microorganisms, 10(12): 2359.
https://doi.org/10.3390/microorganisms10122359

Zhang Y. X., Sun S., Liu Y., Hou W., and Wang G. F., 2022, Global major weather and climate events in 2021 and possible causes, Qixiang (Meteorological Monthly), 48(4): 459-469.