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Sequences in How Climate Change Is Affecting Terrestrial Ecosystems

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Abstract

Based on a variety of ecological and biogeographical data, our goal in this review was to compile the most recent information on the observed and anticipated effects of climate change on the ecosystems of Korea (also known as South Korea or the Republic of Korea, ROK), as well as the primary causes of vulnerability and available options for adaptation. We assembled a collection of peer-reviewed articles released since 2014 in order to achieve this goal. We discovered that, in the field of plant phenology and physiology, the publication of studies related to climate change has declined, while in the field of plant and animal community ecology, this publication has rapidly increased, reflecting the changes in abundance and range shifts brought about by climate change. Research on plant phenology revealed that longer growing seasons are a result of climate change.

Keywords: Ecosystem; Climate change; Animal community.

Introduction

According to community ecology studies, the ranges of warm-adapted organisms may expand and/or shift toward the areas that the previously mentioned cold-adapted biota occupied, while the ranges of cold-adapted plants and animals may contract or shift toward northern and high-elevation areas in the future. This review offers valuable data and fresh perspectives that will advance knowledge of how Korea's ecosystems are being impacted by climate change. It will also be a resource for decision-makers who are trying to decide what sectoral adaptation options to set for the future in order to guard against climate change [1, 2].

Methodology

Due to its high salinity content, the salt marsh, which combines terrestrial and marine ecological traits, has a special ecosystem with environmental value and a restricted plant distribution. In Suncheon Bay's halophyte habitats, alterations in the soil and climate were observed, and fundamental monitoring data on the traits of these habitats and shifts in environmental variables were gathered. When data from the last four years were compared with data from the previous forty years (1973–2013), the environmental variables (temperature, precipitation, relative humidity, and sunshine duration) revealed that while temperature had increased significantly and relative humidity and precipitation had decreased significantly, there had been no significant change in sunshine duration [3].

Climate-related changes were observed in the soil environment parameters pH, soil moisture content, salinity, and electrical conductivity; all of these parameters increased significantly, while the content of organic matter decreased significantly. According to a simulation that uses the sea level rise scenario recommended by the Intergovernmental Panel on Climate Change (IPCC), there will be a 20–45% reduction in salt marsh area by 2100 when compared to the current area. It is anticipated that these changes in ecosystems will have detrimental effects on ecosystem services as well as biodiversity, so appropriate responses and management strategies are crucial.The impact of climate change on plant phenology and the growing season has been the subject of numerous studies.

The majority of plant phenology research has been done at the monitoring level at national research institutes' long-term ecology research sites. A few studies examined correlations between temperature and plant phenology, including those involving temporal variations in the timing of flowering and budburst. A study that used satellite imaging to estimate the timing of budburst over a whole Korean forest found a strong correlation between the timing and the mean temperature of April and the average temperature of the budburst date (3 °C, 12 days).. Five years of research were conducted on Mt. Gayasan regarding the timing of flowering and leafing out of five subalpine plant species: Lilium cernuum, Primula modesta var. hannasanensis, Trientalis europaea subsp. arctica, Ligusticum tachiroei, and Disporuum ovale [4, 5].

Data gathered at 19 meteorological stations in Korea between 1970 and 2013 was used to analyze the growing season shift on a national scale. According to these analyses, leafing out was delayed by an average of 1.4 days/10 years and budburst timing was advanced by an average of 2.7 days/10 years, resulting in an increase in the length of the growing season of 4.2 days/10 years. On the other hand, a local scale study carried out in the urban area of Suwon City revealed that the advanced timing of budburst (~ 4.1 days/10 years) and the delayed timing of leafing out (~ 2.7 days/10 years) resulted in an increase in the growing season of about 6.8 days/10 years.

The start date of spruce growth was advanced and the end date was delayed by climate change between 1972 and 2006, which resulted in an increase in the spruce growing season. However, this increase in growing season was not statistically significantly correlated with spruce growth, according to another local scale study on a spruce community in a mountain area, Mt. Gyebangsan (Jang et al. 2015).By examining changes in plant growth under elevated CO2 and temperature in combination with other environmental factors like soil moisture and nutrients, the effects of climate change on plant physiology and growth have been predicted [6-8].

Results

Bupleurum latissimum's growth was more sensitive to increased

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CO2 and temperature than it was to other environmental factors, such as light, moisture, and nutrients; the combination of increased CO2, temperature, and nutrients produced the greatest growth increase. Abies koreana, a subalpine coniferous species that may be extremely sensitive to climate change, was the subject of the majority of studies on growth change under climate change. Dendroecological research revealed a negative correlation between A. koreana growth and drought stress in springtime on Mt. Hallasan. This suggests that drought stress, which is brought on by a decrease in precipitation and an increase in winter and spring temperatures, would be a major factor in the species' decline in growth and eventual extinction.

The impact of climate change on population genetics dynamics has not received much attention. Determining the ability of plants to adapt to climate change requires an understanding of population genetic diversity and how it changes in response to climatic factors. Twelve populations of Sasa borealis were analyzed nationally using amplified fragment length polymorphism (Kim et al. 2015a). Populations of S. borealis showed a decline in genetic diversity as latitude rose, indicating a negative impact of climate change on the species. National research organizations like the National Institute of Ecology and National Institute of Forest Science have primarily studied the effects of climate change on the synthesis of secondary metabolites and gene expression; however, findings have not yet, National Institute of Forest Science; nevertheless, the findings are still pending publication in relevant journals. In fact, studies on the impact of climate change on secondary metabolite production are relatively new [9, 10].

Discussion

It was anticipated that management would be necessary to address the range shifts of three invasive plant species caused by climate change: Amaranthus viridis, Conyza bonariensis, and Paspalum distichum var. indutum, the potential distribution of A. viridis was estimated to increase by 110% under RCP 4.5 and 470% under RCP 8.5 in 2090. It was anticipated that P. distichum var. indutum would move farther northward and inland. According to Lee, the potential distribution of C. bonariensis was estimated to increase by 338% under RCP 4.5 and 769% under RCP 8.5 in the 2100s.

For instance, when the mean winter temperature in Korea is greater than 10 °C in the 2050s, the Asian tiger mosquito Stegomyia albopicta—which is a vector of Dengue fever and the Zika virus—may be present. Scrub typhus vectors, Leptotrombidium pallidum and Leptotrombidium scutellare, are presently found throughout Korea: L. pallidum is found in the midlands and L. scutellare is found in the southern regions, which includes Jeju-do Island.

Since 2003, the Asian hornet, Vespa velutina nigrithorax, has become more widespread. It is an invasive species of wasp. It was initially discovered in Busan in 2003, and over time, it spread to other counties in Korea, reaching 103 in 2014 and 155 in 2015. The Asian hornet has the potential to spread across the entire nation in the RCP 8.5 scenario. This expansion would alter the interactions between different wasp species, thereby altering the wasp community.Pochazia shantungensis, a brown-winged cicada, is another invasive pest that has been seriously harming trees in orchards and by the sides of roads since 2010. The initial discovery of this Chinese-originated species was made in midwestern Korea, specifically in Gongju and Yesan, Chungchungnam-do. The distribution of this species was primarily influenced by climatic factors, such as summer mean temperature and precipitation; with additional factors including plant species type and forest cover. Given P. shantungensis's present distribution, its range may be limited to the Midwest.

Nevertheless, there are more than 138 species of host plants, including grass, coniferous, and deciduous types. Because of this, the pest species' wide range of host plants may soon because it to spread more quickly.It has been demonstrated that raising the temperature can regulate how quickly some insects that are sensitive to high temperatures develop. By taking into account high-temperature susceptibility above 40 °C, Kim et al. (2016c) examined the cause of changes in the seasonal occurrence of two moth species, Plutella xylostella and Spodoptera exigua, both of which are significant pest species of cabbage. Because heat-shock protein coding genes like Hsp70, Hsp74, and Hsp83 in P. xylostella translated into proteins involved in the control of temperature stress and the synthesis of glycerol (i.e., blood sugar), they discovered that P. xylostella was more sensitive to high temperatures than S. exigua. Nonetheless, pest species populations may be impacted by global warming regardless of whether they possess physiological defenses against temperature fluctuations.

Conclusion

Throughout this review, we have seen that in response to climate change, Korean plants and animals have been expanding or moving their ranges northward, and populations have been migrating, maturing, or reproducing earlier than they would have in the past. This will cause asynchronies in the food web, which will ultimately make species and ecosystems more vulnerable. By the end of this century, about 20–30% of plant and animal species—including those that are climate-sensitive and/or adapted to alpine or subalpine habitats—may go extinct. Continuous climate change has resulted in ecosystem degradation and biodiversity loss when combined with human disturbances. At the local, regional, national, and international levels, ongoing monitoring of ecosystem change is necessary to track phenology, population fluctuations, and pest outbreaks. Appropriate conservation management and practices at the genetic and population levels should also be adhered to.

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