FACTSHEET

Effects of climate change on arctic vegetation

Background

Biological processes in the Arctic are considerably hampered by temperature and permafrost. Generally arctic ecosystems lack nutrients because the large quantities of organic materials in the soil are located in the thick layer of permafrost. The soil from which the plants obtain their nutrients for growth is thin, and most plant species are therefore limited to the nutrients available in this thin layer of soil. A general increase in temperature in the Arctic as a result of global warming would increase the decomposition of the large quantities of organic materials that are frozen in arctic soil. This would in turn result in thicker soil and at the same time release considerable quantities of nutrients (e.g., nitrogen and phosphorous). Combined with increased concentrations of CO_2 in the atmosphere there would be an increase in the production of plant biomass as a result of increased photosynthesis. Consequently, there would be an increase in the production of arctic vegetation, but at the same time it is anticipated that there would be a substantial change in the combination of species in plant communities. This is linked to the fact that different plant species have varying degrees of sensitivity to changes in environmental parameters such as access to nutrients and temperature. Those species that are able to cope with change would become more dominant than those that are less adaptable.

Changes in plant communities

Some species and forms of plant growth are better competitors than others in the fight for limited resources such as nutrients, temperature and access to sunlight. An increase in woody vegetation (e.g., the dwarf birch, *Betula nana*), has already been observed in several places in the Arctic at the expense of herb and grass species.

The same trends are also evident in the results of 13 different arctic research projects. In many plant communities where woody vegetation is on the increase, there has been a reduction in the diversity of plant species. Woody vegetation trumps herb and grass species in the battle for nutrients and access to sunlight. Scientists have also observed that more extensive woody vegetation is having a negative impact on the distribution of mosses and lichens. Species that are specially adapted to an arctic climate (and are thus only found in such areas) will be suppressed by species with a wider distribution, resulting in an overall reduction in biodiversity. Such changes in the diversity of species in plant communities could in turn have a major impact on the animal groups that live off or use the plants for other purposes.

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Alpine campion (*Viscaria alpina*)

Geographical distribution

Most plant species living in the Arctic have adapted in order to carry out their biological processes, such as growth and propagation, just above or below 0°C. These properties have provided them with a competitive advantage over the more the heat-loving species that live further south. In a warmer climate this competitive advantage would no longer apply and the southern species would start to migrate northwards where they could suppress the local arctic species. This is particularly relevant to mainland Norway where the same trends were observed when the ice receded after the last ice age. For Svalbard the picture is not as clear cut. Genetic studies show that when the last ice age was over, many plant species migrated from both Russia and Greenland. This migration depended on whether or not a species was dependent on wind dispersal (mountain avens and dwarf birch) or bird dispersal (bog bilberry and crowberry). Some species are dispersed by ocean currents and changes due to a warmer climate would also affect the migration of species to Svalbard.

The growth season

Arctic plants are exposed to extremely low temperatures and experience a very short growth season. In order to ensure reproduction, it is therefore important for these plants to flower and seed as early as possible before the onset of frost in the autumn. Many species form flower buds during the previous year so that they can start flowering as soon as the conditions are right during the spring. In a warmer climate the growth season in the Arctic would be extended. Spring would arrive earlier and autumn would start later than at present. This would have a major impact on the phenological development of the plants.

Phenological changes

Phenology refers to the timing and duration of biological phenomena. For plants the relevant times are when plants come into leaf, when buds are formed and when they flower and seed. Some species will respond to earlier snow melting by having an earlier phenological development. Other species will not experience the same change. Such species-specific changes in phenological development can give some species competitive advantages if the climate changes. In the Arctic the length of the growth season is a limiting factor for the spread of species so that the earlier a plant develops and seeds the more likely it is that its seeds will set before the onset of frost in the autumn. In the long term, phenological changes can contribute towards changing the composition of plant communities.

For animals that are dependent on following the phenological development of plants, a change in the time when plants flower could be significant. Synchronicity has been observed between reindeer calving and plant phenology. Earlier phenological development could have an impact on calf populations (see factsheet on reindeer). Several species of insects have a symbiotic relationship with flowering plants due to pollination biology. This relationship could be upset if the plants were to flower earlier than usual, and this could have an impact on both plants and insects. A lack of pollination would be detrimental to plant formation.

Reproduction

A warmer climate generally has a positive impact on plant reproduction and the effects are more marked in the high Arctic than in the low- and sub-Arctic. At the same time, some studies have shown that a warmer climate has little or no negative impact on the reproduction of some plants. Such species-specific differences in reproduction can result in major consequences for the competitive relationship between species and the composition of plant communities. For example, purple saxifrage (*Saxifraga oppositifolia*), the glacier buttercup (*Ranunculus glacialis*) and alpine mouse-ear (*Cerastium alpinum*) have shown little response to a warmer climate, while canescent whitlow grass (*Draba cana*) suffers from reduced fertility in a warmer climate. In places where these species co-exist, the whitlow grass would probably lose out in competition against the other species.

Mountain avens (*Dryas octopetala*)
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Reduced plant diversity caused by climate change results in reduced biodiversity in other links in the food chain.

Conclusion

Generally it is difficult to say exactly how the climate will affect plants in the Arctic because the changes are species-specific. However, botanists have observed that the species-composition of plant communities is changing. An increase in the dominance of woody vegetation (e.g., dwarf birch and species of willow) is already resulting in diminished diversity among pteridophytes. How this will affect other species that are dependent on the plants that are disappearing is not yet clear. However, there is no doubt whatsoever that this will have consequences. Insect species specialising in the species that are disappearing will undoubtedly also suffer from drastic reductions in their populations or they could disappear completely. Reduced plant diversity caused by climate change results in reduced biodiversity in other links in the food chain.

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