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Watermelon Snow - An Alarm of Climate Change

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Abstract

"Watermelon snow" or "Glacier blood" or "Red snow" refers to red-colored snow, caused by bloom of cold-adapted phototrophs, so-called snow algae. Red snow algae-*Chlamydomonas nivalis*, commonly cause these red snows. The pigment responsible for the red color of adult *C. nivalis* cells is the secondary carotenoid astaxanthin and its fatty acid ester derivatives. Other causative algal blooms also recently regarded *Sanguina* sp., which causes unusual orange snow, was also found in Svalbard. The recent researchers found forms of *Sanguina* sp. algae that cause red snow samples from Europe, North America, and South America along with both Polar Regions. The red snow raises concerns about the rate at which the glaciers will melt away and eventually affect sea-level rise. It was suggested that glaciers should be careful because it absorbs more heat, resulting in which it melts faster.

Introduction

In high-altitude or high-latitude areas, red, orange, and green colors are occasionally observed on snowfields during the snow-melting period. Red-coloring of snow is commonly called "red snow" caused by a bloom of specific unicellular algae. The Greek philosopher Aristotle is believed to be one of the first to give a written account of watermelon snow over 2,000 years ago. In the "History of Animals" Aristotle has mentioned, living animals are found in substances that are usually supposed to be incapable of putrefaction; for instance, worms are found in long-lying snow; and snow of this description gets reddish, and the grub that is engendered in it is red, as might have been expected, and it is also hairy. During the 20th century, systematic studies on these algae have been undertaken to identify the different species growing on or in the snow and to describe the species causing not only 'red snow' but also green, yellow, orange, or even grey snow. Snow algae are a group of freshwater microalgae that have encountered the extreme habitats of persistent snow and glacier fields in the polar and high-alpine regions (Remias *et al*., 2005).

Watermelon snow, also called snow algae, pink snow, red snow, or blood snow, is a phenomenon caused by *C. nivalis*, a species of green algae containing a secondary red pigment-astaxanthin in addition to chlorophyll. Snow algae frequently occur in persistent or permanent snow ecosystems in the Alps or the Arctic. When the snow algae grow prolifically and are exposed to strong solar radiation, they produce high concentration of red-coloured pigment molecules known as carotenoids (astaxanthin), which act as a sunshield to protect their chlorophyll against excessive UV irradiation.

Occurrence of Red Blood Snow

Studies have shown red algal blooms occur on glaciers all over the world, from Antarctica to the Himalayas and in the Arctic. Red snow has been observed in many parts of the world, such as alpine and high latitude of Europe, western North America, Australia, New Zealand, South America, North Africa, Arctic regions, coastal Antarctica and surrounding islands. Although the size of the colored region varies from site to site, wide-area research based on remote sensing revealed the presence of substantial biomass in the colored snowfield. These snow algae are highly productive despite harsh environmental conditions on the surface of the snow. High rates of CO_2 uptake have been observed in the blooms of snow algae. It also has been reported that these snow algae play an important role as primary producers, which sustain a community consisting of cold-adapted organisms such as the ice worm, collembola, and bacteria.

Figure 1: Red blood snow of French Alps (Source: BBC, 2021)

Types of Snow Algae

Fiolka *et al*. (2020) explained Snow algae are photosynthetic microbes growing in thawing snow. They usually show various morphological cell type. Snow algae are photosynthetic microbes growing in thawing snow. Snow algae grow in the polar snow fields and in high-altitude mountain tops. Red snow caused by spherical cysts, traditionally addressed as "*Chlamydomonas nivalis*", is probably the most common type of snow algal bloom in the Arctic and elsewhere. To a lesser extent, orange snow containing spherical cysts was reported from the Arctic as well. Recently, the algae of the two bloom types were described as distinct species: *S. nivaloides* causing red snow and *S. aurantia* causing orange snow. The snow algae may be conveniently divided into three main groups based on the color they impart to the snow: grey, red or green. The red snow algae was previously identified as *Protococcus nivalis* which is synonymous with *C. nivalis*. *C. nivalis* produces substantial biomass even under extreme conditions, such as low temperature, high light, low pH, nutrient deficiency, freeze-thaw cycles, and UV irradiation, and thus serves as a vital food source for other cold-adapted organisms, such as ice worms, collembola, and bacteria. During the summer, when these typically green algae get a lot of sun, they start producing a natural sunscreen that paints the snow in shades of pink and red. In the winter months, they lie dormant.

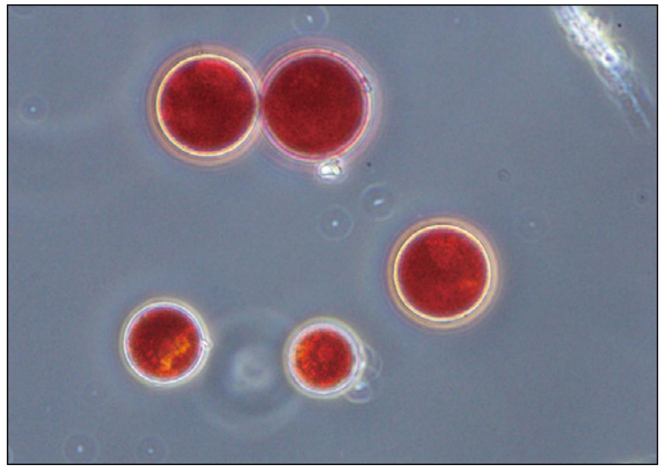

Figure 2: Microscopic view of snow algae (Segawa *et al*., 2018)

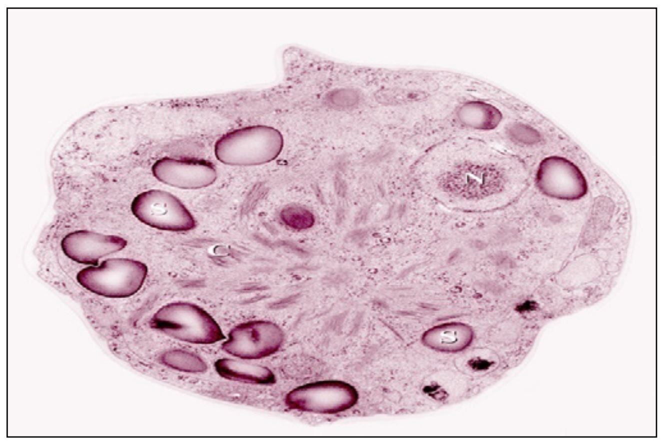

Figure 3: *Chlamydomonas nivalis* (Source: DW, 2020)

Species Responsible for Red Blood Snow

Most snow algae belong to the genera *Chlamydomonas* and *Chloromonas* (Chlorophyta, Volvocales). It is essential to consider their habitat when undertaking physiological measurements. Snow algae frequently occur in persistent or permanent snow ecosystems in the Alps or the Arctic. During summer, they have to adapt to extreme temperature regimes, high irradiance, and low nutrient levels. Snow algae live in a unique microhabitat, namely the liquid water between snow crystals. For cells to be physiologically active, the snow must be neither too cold nor too dry (as with freshly fallen snow). Flagellated stages enable these organisms to change their position within the snow layer to reach the optimal depth for their light and temperature requirements. Most life-cycle occurs as the immotile hypoblast stage because this form is the most resistant to environmental changes, such as daily freeze-thaw cycles. Most of the algae in polar snow algal community belong to Chlorophyceae, Chlamydomonadales or Volvocales, some of which have received more attention in recent years, such as *C. nivalis*, *Chloromonas reticulate*, *Sanguina nivaloides*, and *S. aurantia*. *C. nivalis*, belonging to the genera Chlamydomonas (Chlorophyta) and closely relating to the model algae *C. reinhardtii*, is a typical snow alga and a leading system for investigating cold adaptation.

Other Causative algal blooms also recently regarded that species of *Sanguina* that causes an unusual orange snow was also found in Svalbard. Recently found that it isn't the only type of microalgae responsible for red snow, though. Several other types, such as *C. nivalis* and an algae found growing close to Antarctic penguin colonies called *Chloromonas polyptera*, also produce pigments to create red and pink stained snow. But understanding more about red snow algae carries significance far greater than simply explaining the existence of strange-colored patches in the Alps and near the poles. Its appearance and disappearance are important markers of climate change and how it is affecting the delicate ecosystems where the algae are found *Mesotaenium berggrenii, Chloromonas rubroleosa.*

Effects

Significantly, however, the red snow raises concerns about the rate at which the glaciers will melt away and eventually affect sea-level rise. According to the Alaska Pacific University, the melting snow is good for the algae that thrive on it, but bad for the glaciers that are already melting. The algae produce the tinted sunscreen to keep themselves warm. The report mentions that because the snow becomes darker from the tinge, it absorbs more heat, as a result of which it melts faster. Blooms of these microalgae significantly decrease snow and glacial surface albedo due to their pigmentation, thus, accelerating melting processes additionally to global warming. Scientists believed that, the red snow is becoming more common due to global warming. The rise in the atmospheric carbon dioxide levels increases the temperature, which leads to more snow melting. The moment there is liquid water on the snow, the algae start growing. This increasing abundance of red snow algae may also be contributing to climate change. The red pigment turns the snow surface dark, reducing the amount of light and heat it reflects back into space - something known as the albedo effect. By trapping more of the Sun's heat, the snow melts even faster, allowing the algae to proliferate further (Fiołka *et al*., 2020).

Conclusion

Overall, found the species which are responsible for red pigmentaion. It is not only caused by *C. nivalis*. The recent research found the researchers found forms of *Sanguina* algae that cause red snow samples from Europe, North America, and South America along with both Polar Regions. The red snow raises concerns about the rate at which the glaciers will melt away and eventually affect sea-level rise. Because the snow becomes darker from the tinge, it absorbs more heat, as a result of which it melts faster. It was suggested that glaciers should be careful because it absorbs more heat, as a result of which it melts faster.

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