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REVIEW ARTICLE

Animal, Microbial, and Fungal Borne Skin Pathology in the Mountain Wilderness: A Review

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Mountains are home to numerous organisms known to cause skin disease. Bites, stings, poisons, chemicals, toxins, trauma, and infections all contribute to this end. Numerous plants, animals, fungi, bacteria, viruses, and protozoa are responsible. This paper aims to review skin illness and injury sustained from organisms in the mountains of North America. Other factors such as increased ultraviolet radiation, temperature extremes, and decreasing atmospheric pressure along with human physiologic parameters, which contribute to disease severity, will also be discussed. After reading this review, one should feel more comfortable identifying potentially harmful organisms, as well as diagnosing, treating, and preventing organism-inflicted skin pathology sustained in the high country.

Keywords: dermatology, mountains, dermatitis, bites, envenomation, animal attacks, wilderness, altitude

Introduction

Mountainous terrain covers approximately 22.5% (1.8 million square kilometers) of the contiguous United States (Figure 1). Globally, 20% of Earth's lands are mountainous, with an estimated 400 million permanent human residents.[1] Additionally, mountains attract a large number of visitors for work, recreation, and religious reasons.[1] Outdoor recreation, including hiking, skiing, mountaineering, climbing, and rafting have become very popular in the past century.[2] Both permanent residents and visitors are exposed to common and unique dermatological injuries and illnesses. This paper reviews skin disease caused by fungi, bacteria, Animalia, protozoa, and viruses in the mountains of North America.

Plants are responsible for a number of skin reactions including contact and irritant dermatitis, urticarial rashes, phytophotodermatitis, and rashes secondary to Euphorbiaceae and saponin plant toxidromes.[3–6] Tick-borne vector illnesses including anaplasmosis, ehrlichiosis, Lyme disease, and rickettsial illnesses such as Rocky Mountain spotted fever, tularemia, tick-borne relapsing fever, and Colorado tick fever are also known to cause rash.[7–9] As skin pathologies from plants and tick-borne vector illnesses represent extensive topics and are already well-cited in the medical literature, they have been omitted from this review. Please reference the above cited sources for more information on these interesting topics.

No universally accepted criteria exist with regard to what constitutes a mountain, hill, or mountainous terrain. In this review, the authors defined mountainous areas according to topographic relief. Any increase of $\geq$100 m (330 feet) elevation over a horizontal distance $\leq$2 km (1.24 miles) met criteria for mountain terrain (Figure 1). This definition is intentionally inclusive and does not exclude terrain based on absolute altitude. These environments are, among themselves, highly variable ranging in elevation from sea level to 6190 m (20,310 feet; Denali, Alaska) in North America.[10] As such, the degree of exposure to weather and ultraviolet radiation, along with potentially harmful organisms encountered,

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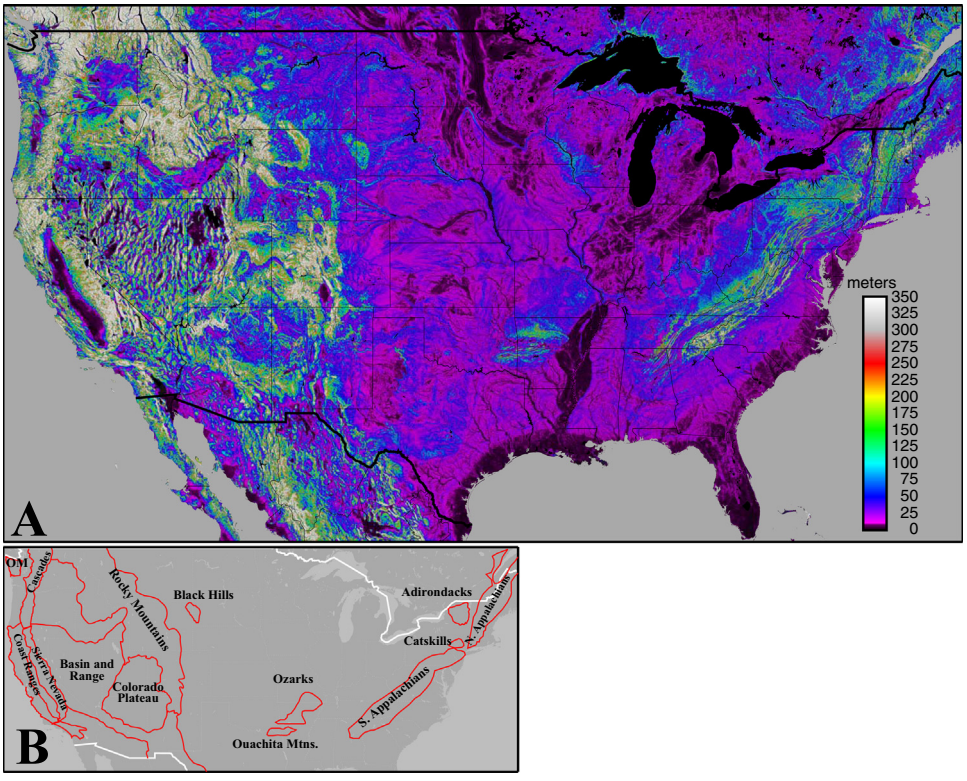

Figure 1. A, Topographic relief within a 3 km (~1.9 mile) radius, defined as the elevation of each point on a 0.5 x 0.5 arcsecond grid minus the lowest elevation of any grid point within 3 km. Low-relief areas (eg, river valleys, lakes) plot as black. Mountainous areas plot as green to white. B, Outlines of mountainous areas in the conterminous United States. OM, Olympic Mountains. Topography data from: http://www.gebco.net/data_and_products/gridded_bathymetry_data/.

differ substantially between ranges and even within habitats on a given mountain. Some organisms are unique to the mountain wilderness, while others may be encountered in multiple outdoor settings.

Exposure to ultraviolet radiation increases roughly 1% for every 30 m of elevation gain. Temperatures drop approximately 1°C for every 150 m of elevation gain. The atmospheric pressure decreases with altitude, therefore lowering the amount of oxygen available for respiration. At 2000, 4000, 6000, and 8000 m, respectively the available oxygen is only 79, 63, 49, and 37% of that at sea level (about 1% less per 110 m gain to 5000 m). Relative humidity also decreases with elevation while weather, including wind speed, temperature gradients, precipitation, and overall exposure are often more severe, more difficult to predict, and highly variable.[1,11,12] All of these factors often contribute to make skin pathology more severe and difficult to treat in the mountain environment.

Fungi: Mushrooms

Contact dermatitis (CD) from the *Toxicodendron* species (poison ivy, oak, and sumac) and other varieties of plants is the most common cause of CD, thought to be responsible for greater than 50 million cases per year in the United States.[3] Much less well-known is CD from mushrooms, the fruiting bodies of fungal organisms, when handled by susceptible individuals.[13] The pruritic rash is typically reported as erythematous swelling at the site of contact. Rashes develop in 1 or 2 days and last about 1 week.[13] No treatment is necessary and either avoidance or use of rubber gloves is recommended for prevention.[13] Culprit genera include *Ramaria, Paxillus, Lactarius, Boletus, Agaricus,* and *Suillus. Suillus granulatus* (Figure 2) can be found after summer rains on the pine-covered foothills of the Rocky Mountains.[14]

Bacteria: *Staphylococcus, Streptococcus*, and *Yersinia*

In recent epidemiological studies, cellulitis represented 2 and 4% of total illnesses among participants in National Outdoor Leadership (NOLS) classes.[15,16] Abscesses, carbuncles, furuncles, pyoderma, erysipelas, and wound infections are also known to occur in the mountain wilderness.[1,17] Causal bacteria are generally *Staphylococcus* and *Streptococcus* species.[18]