Polarized light pollution: Alternative hypotheses and resource management concerns

HORVÁTH ET AL. (2009) INTRODUCE THE TERM "POLARIZED light pollution" and suggest caution in the placement and use of artificial polarizers. Polarized light pollution refers predominantly to highly and horizontally polarized light reflected from artificial surfaces, which alters the naturally occurring patterns of polarized light experienced by organisms in ecosystems. Common artificial polarizers are asphalt surfaces (e.g., roads and parking lots), black plastic sheeting, dark-colored paint work (e.g., on cars), black (polished, horizontal) gravestones, and black or gray windows. Oil spills and open-air oil reservoirs are locally significant artificial polarizers. Similar to a polarizing filter on a camera, an artificial polarizing surface reduces reflection from nonmetallic surfaces, increases contrast and color saturation, and darkens shadows. In the 1960s, research began to show that many animals are capable of perceiving the polarization of light and using it as a rich source of information (see Horváth et al. 2009, p. 317).

Generally, light pollution is a nighttime phenomenon, affecting nocturnal and crepuscular species; however, polarized light pollution can occur day or night wherever both a light source and a polarizing surface are present. Furthermore, the magnitude and prevalence of polarized light pollution have greatly increased with human activity. Horváth et al. (2009) highlight the potential effects of polarized light pollution on habitat selection, laying eggs, foraging, navigation and orientation, predation, and population dynamics. The following examples show some of the direct and indirect effects on the behavior and fitness of polarization-sensitive animals.

Perhaps most obviously, water-seeking insects use horizontally polarized light to locate water bodies. Among available visual cues, polarization is the most reliable under variable lighting conditions. Yet, foraging on artificial polarizers (e.g., a red car roof) wastes time and energy for these species. Moreover, for some species, landing on artificial reflectors can be lethal; obligate waterbirds (i.e., birds that require open water for survival) such as ruddy duck (*Oxyura jamaicensis*), common loon (*Gavia immer*), dovekie (*Alle alle*), and brown pelican (*Pelecanus occidentalis*) are occasionally found dead or injured and stranded (unable to take off) in large asphalt parking lots.

Predators use polarization sensitivity (e.g., detection of prey via the scattering of light) to their advantage, but in underwater habitats, plastic garbage is a source of polarized light pollution. Investigators have identified plastic bags as attractive to sea turtles because of the plastic's transparency and similarity in shape to jellyfish; park literature at Cape Lookout, Canaveral, and Padre Island national seashores highlights such findings (see particular parks at http://www.nps.gov). Horváth et al. (2009) suggest that scattered light through plastic may prompt aquatic organisms to consume inappropriate and dangerous items sensed as prey.

Artificial surfaces that reflect light may easily become polarization signals to which different species are attracted. However, the degree of artificial polarization can far exceed natural levels, disorienting species from native cues in both sky and water.

Cascading effects may result if predators, which initially benefit from the abundance of prey attracted to artificial surfaces, become prey themselves. For instance, nest predators such as magpies (*Pica pica*) that gather near caddisfly (*Hydropsyche pellucidula*) congregations (attracted to vertical glass surfaces) could represent an enhanced predatory risk for the chicks of other bird species that nest in the immediate vicinity of glass buildings. Finally, because artificial surfaces can polarize light more highly than water, aquatic insects prefer to settle and lay eggs upon artificial, horizontally polarizing surfaces, even when there are suitable water bodies nearby. Such maladaptive behavior may result in population declines or alter the structure, diversity, or dynamics of ecological communities.

Although conservation is the primary objective of Horváth and his colleagues, they also supply a provocative alternative hypothesis for the accumulation of life-forms at ancient natural asphalt seeps such as Rancho La Brea in Los Angeles, California. The generally accepted hypothesis is that animals were initially caught when they accidentally stumbled into the tar pits, which may have been camouflaged by dust or leaves (Akersten et al. 1983). Horváth et al. (2009) hypothesize that "these asphalt seeps may sometimes have been covered by rainwater, thus strengthening their polarization signature and attracting polarotactic insects and birds, and initiating a cascading trap for predators attracted to the trapped prey species" (p. 323).

Anthropogenic polarizing surfaces, combined with the occurrence of sensitivity to polarized light in so many animal taxa, suggest that caution in the placement and use of artificial polarizers is warranted from a conservation perspective. According to Horváth et al. (2009), "the ever-increasing levels of polarized light pollution and its ability to negatively affect behaviors and to alter interspecific interactions constitute an important conservation problem, which requires increased attention from conservation professionals and researchers alike" (p. 324).

References

Akersten, W. A., C. A. Shaw, and G. T. Jefferson. 1983. Rancho La Brea: Status and future. Paleobiology 9:211–217.

Horváth, G., G. Kriska, P. Malik, and B. Robertson. 2009. Polarized light pollution: A new kind of ecological photopollution. Frontiers in Ecology and the Environment 7(6):317–325.

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