Artificial Lighting Reshuffles Ecosystems, Study Finds

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Do you suffer from insomnia because your bedroom is not dark enough? Nature does, too. In recent decades, as we illuminate the night sky, we disrupt the natural cycle of light and dark that has been there for billions of years. This causes much more troubles than sleep deprivation. "Demographic effects of artificial nighttime lighting on animal populations," the Environmental Reviews study by Kevin J. Gaston and Jonathan Bennie from Environment and Sustainability Institute, University of Exeter was the first to comprehensively survey the impact of artificial lighting on the population dynamics of animal species from the "key demographic parameters of a local population of a species, namely immigration, births, deaths, and emigration." (Gaston, et al 2014)

In terms of immigration, species can be influenced by artificial light in two different ways. There are light-distracted species and light-exploiter species. Due to stimulus from artificial lighting, light-distracted species migrate to somewhere they usually don't because of their instincts. Moths flying towards streetlights and birds disoriented by city lights during migration season are some common examples. They are genetically programmed to navigate by the moon and stars, the impulse of which is failing due to artificial lights. The light-exploiter species, on the other hand, see light at night as an opportunity. As found by previous researches by Steven Garber[1] and Kenneth Frank[2], "some otherwise diurnal predators extend their foraging

[1] Garber, S.D. 1978. Opportunistic feeding behaviour of *Anolis cristatellus* (Iguani- dae: Reptilia) in Puerto Rico. Transactions of the Kansas Academy of Science, **811**: 79–80. doi:10.2307/3627360.

[2] Frank, K.D. 2009. Exploitation of artificial light at night by a jumping spider. Peckhamia, **78.1**: 1–3.

hours under artificial nighttime lights" because "[preys] are simply made more detectable in the presence of lights." (Gaston, et al 2014)

The cycle of day and night controls the circadian clock, or "internal clock," of many species including humans. Now, as night becomes brighter, our bodies cannot tell whether it is day or night and this causes headaches, insomnia, etc. In the long run, bright night even alters life cycles. Many studies[3] have found that "animals at mid to high latitudes use seasonal changes in day length as a cue to initiate such events as reproduction, eclosion, diapause, moult, embryonic development, and migration." (Gaston, et al 2014) Now, these animals cannot sense the difference between day and night, and their development stages can become seriously out of phase, leading to a shift in reproductive rate. On the other hand, some light-exploiter species can use this extra "day time" to breed, and thus increase the birth rate.

Now that we have talked about birth, we'll talk about death. Light-distracted species experience a higher mortality rate because they wasted too much time and energy chasing lights, were disoriented and arrived somewhere without food, and were preyed on by light-exploiters. Speaking of light-exploiters, some species, in contrast, only feed in darkness. They have a much shorter time every day to find food with the presence of artificial lighting. Even though they can move to other places (though oftentimes this option isn't available), it comes with a cost "including reductions in time for feeding and increased risks of predation" (Gaston, et al 2014). Higher mortality rates for these species are inevitable.

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[3] Gwinner, E. 1977. Photoperiodic synchronization of circannual rhythms in the European starling (*Sturnus vulgaris*). Naturwissenschaften, **64**: 44 – 45. doi:10. 1007/BF00439901.
Niva, C.C., and Takeda, M. 2003. Effects of photoperiod, temperature and melatonin on nymphal development, polyphenism and reproduction in *Halyomorpha halys* (Heteroptera: Pentatomidae). Zoological Science, **20**: 963–970. doi:10. 2108/zsj.20.963. PMID:12951401.
Dawson, A., King, V.M., Bentley, G.E., and Ball, G.F. 2001. Photoperiodic control of seasonality in birds. Journal of Biological Rhythms, **16**: 365–380. doi:10. 1177/074873001129002079.

Last but not least, emigration. There were few studies on the effect of artificial lighting on the emigration of species. Gaston et al speculate that “at least in the initial introduction of such lighting the individuals of some species will depart elsewhere.” Light-exploiters might move to lit areas while some species feeding in darkness might move to darker places to recover their lost feeding time due to artificial lighting.

The equilibrium of immigration, birth, death, and emigration determine the population of a species, and the equilibrium of the population of all species determines the structure of the ecosystem. Artificial light has changed the different demographic factors of different species on a different scale, and we can’t know what will happen next, as Gaston et al mentioned, “good model organisms for the study of the impacts of artificial nighttime lighting on demographic parameters have yet to emerge.” Without a doubt, the ecosystem will never be the same as before. Will it reach a new equilibrium under the streetlights? Or will it go down a slippery slope and eventually crash and burn? Only time will tell.