

Dung beetles found to use different celestial navigation cues depending on species

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Scarabaeus viettei (syn. *Madateuchus viettei*, Scarabaeidae); picture taken in dry spiny forest close to Mangily, western Madagascar. Credit: Axel Strauß/Wikipedia

(Phys.org)—A team of researchers with member affiliations to Lund University in Sweden and the University of Arizona in the U.S. has found that two species of dung beetles navigate differently depending on whether they are diurnal or nocturnal. In their paper published in *Proceedings of the National Academy of Sciences*, the group describes their study and offers a theory on how one species navigates when there is no light from either the sun or moon.

Dung beetles quite often are the butt of jokes, collecting as they do, pieces of excrement from other animals, forming it into a ball and then rolling it across the ground to a private destination. But, they have pretty sophisticated navigation skills—they can roll their ball of dung in a [straight line](#), despite uneven terrain, ending up in a spot they pick some distance from where the dung was found. Prior research has shown that the beetles use celestial cues to help keep themselves oriented, but just how they do that has been a mystery—until now.

In this new effort, the researchers studied specimens from two [species of dung beetles](#), diurnal (those that operate mainly during the day) and nocturnal. They did so by collecting specimens, putting them in an artificial environment where celestial cues could be modified and then watching how the beetles performed—that allowed for identifying which celestial cues were at play. They found that as expected, diurnal beetles depended on the sun's location during the day, and on the moon's location at night. But the nocturnal beetles depended on polarized light from the moon at night and the sun during the day.

Next, the research group took a closer look by making electrophysiological recordings of the beetles' brain cells as they were exposed to sun and moon light. That showed that the nocturnal species had neurons that would switch between responding to polarized light and light from the sun, whereas the neurons in the brains of the diurnal species switched between responding to light from the sun or the moon.

The team also theorized that the nocturnal species' navigate at night when there is no [polarized light](#) from the moon available, by using [light](#) from the Milky Way.

More information: Neural coding underlying the cue preference for celestial orientation, Basil el Jundi, [DOI: 10.1073/pnas.1501272112](https://doi.org/10.1073/pnas.1501272112)

Abstract

Diurnal and nocturnal African dung beetles use celestial cues, such as the sun, the moon, and the polarization pattern, to roll dung balls along straight paths across the savanna. Although nocturnal beetles move in the same manner through the same environment as their diurnal relatives, they do so when light conditions are at least 1 million-fold dimmer. Here, we show, for the first time to our knowledge, that the celestial cue preference differs between nocturnal and diurnal beetles in a manner that reflects their contrasting visual ecologies. We also demonstrate how these cue preferences are reflected in the activity of compass neurons in the brain. At night, polarized skylight is the dominant orientation cue for nocturnal beetles. However, if we coerce them to roll during the day, they instead use a celestial body (the sun) as their primary orientation cue. Diurnal beetles, however, persist in using a celestial body for their compass, day or night. Compass neurons in the central complex of diurnal beetles are tuned only to the sun, whereas the same neurons in the nocturnal species switch exclusively to polarized light at lunar light intensities. Thus, these neurons encode the preferences for particular celestial cues and alter their weighting according to ambient light conditions. This flexible encoding of celestial cue preferences relative to the prevailing visual scenery provides a simple, yet effective, mechanism for enabling visual orientation at any light intensity.

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