

In the summer of 2014, I taught a four-day writing workshop for my school's teachers. Everyone, myself included, had to write three documents that corresponded to what the Common Core expects children to do: write to (1) persuade; (2) explain; (3) tell a narrative, either fiction or non-fiction. The document below is my "writing to explain" piece.

Crepuscular

When my husband and I adopted two kittens a decade ago, our Brooklyn apartment had a long hallway with wooden floors. Every morning at dawn, Tako and Toro would race from one end of the hall to the other, back and forth at terrific speeds, for twenty minutes or so, toenails clicking on the wood. Then they would stop, mosey up to our bedroom door (which was closed), and scratch, *scratch*, SCRATCH a demand for breakfast. After we got up and fed them, they'd go to sleep like little angels. It was cute at first but quickly became annoying. Every day at dawn! Even on weekends!

"Well, of course they do that," a friend said. "They're crepuscular."

Thus I learned a new word, a new concept. Until then I had thought that animals were either *diurnal* (active during the day) or *nocturnal* (active at night). I'm sure I was taught this in primary school. But in fact, many animals are *crepuscular* – most active an hour or so around dawn, and again at dusk. This is true for animals that are prey (mice, ferrets, rabbits) as well as those that hunt them (bobcats, nighthawks, Tako and Toro). Twilight is a busy time for many of the world's creatures.

When we moved to the Bronx, our new apartment, too, had a long hallway. Our cats continued to race up and down at dawn, and I continued to ponder this crepuscular business. After a while I came up with this question: Since so many animals are crepuscular, how do they adjust their body clocks as the hours for dawn and dusk shift through the year? In New York, for example, the sun rises in June at about 5:30 a.m. and sets around 8:30 p.m. But in December it rises around 7:15 and sets at 4:30. What does this mean for crepuscular animals?

I thought there'd be a simple, one-size-fits-all answer, but I was wrong. On the one hand, many animals adjust their body clocks through a process called *entrainment*, which is similar to the way humans adapt to waking and sleeping in a different time zone. On the other hand, everything depends on a variety of factors. Crepuscularity is complex and a huge area of research.

Entire doctoral dissertations have been written about changing crepuscular habits of specific species in specific locations. For example, for his doctoral research at the University of Arizona (*Diurnal and Seasonal Locomotory Activity in the Gila Monster*), Peter Lardner plotted the time that Gila monsters started to move about each day, in the Arizona desert as well as in controlled laboratory environments. Over six years, Lardner collected data on more than 200 Gila monsters, an animal he describes as a venomous though "rather pleasant and interesting lizard." He found that in the wild, Gila monsters are diurnal when they first emerge from winter hibernation, but then move into a crepuscular lifestyle later in the spring and for the duration of the summer. In the fall they tend towards diurnality until it's time to hibernate again. Two factors drive the variance: light and temperature.

Deer are another story. According to huntingnet.com (a website for people who slaughter wild animals), deer are predominantly crepuscular – are more likely

to be out and about – when the moon isn't full. The full moon always rises at sunset and sets at dawn. Deer are less likely to forage at night during a full moon because they are more easily visible than to predators. When the moon is full, they adjust their normal feeding activity.

Gender also plays a role for deer. A team of German researchers studied the annual activity patterns of European roe deer in the Bavarian Forest National Park. In the conclusion of their findings, they write:

The activity patterns of the two sexes were similar, except that the crepuscular activity of the males was more distinct during spring and summer. The females, in contrast, showed crepuscular activity during these seasons but also were active during the day. This extended [foraging] activity could be explained by the 50 % higher energy demands of the females in these seasons during gestation and lactation than in winter.

Finally, location and who your neighbors are also play a role. For example, according to Wikipedia, “the subspecies of Short-eared Owl that lives on the Galápagos Islands is normally diurnal, but on islands like Santa Cruz that are home to the Galapagos Hawk, it is crepuscular.”

Thus, there are no neat dividing lines separating diurnal animals from nocturnal from crepuscular. This gives me more to ponder when I wake at dawn, hearing my cats' meows.

I learned a lot of new vocabulary because of this research. Crepuscular animals that are active only at dawn are *matutinal* (including some species of bees;

this is why we have morning glories). Animals that are active only at dusk are *vespertine* (for example, moths). Animals that are active at both dawn and dusk display a *bimodal activity pattern* (Tako and Toro). Animals that alternate sporadic and random periods of activity and rest throughout a 24-hour period are *cathemeral* (me in grad school).

This investigation broadened my understanding of the crepuscular nature of animals, but I still have much to learn. My initial question (*Since so many animals are crepuscular, how do they adjust their body clocks as the hours for dawn and dusk shift through the year?*) remains an issue, because when I try to read about entrainment I am confronted by many terms which I understand partially or not at all: *circadian rhythm, environmental oscillation, endogenous*. For example, Wikipedia, which normally clarifies things, left me dumbfounded with this paragraph:

The activity/rest (sleep) cycle in animals is only one set of circadian rhythms that normally are entrained by environmental cues. In mammals, such endogenous rhythms are generated by the suprachiasmatic nuclei (SCN) of the anterior hypothalamus. Entrainment is accomplished by altering the concentration of clock components through altered gene expression and protein stability.

After grappling with that paragraph, I needed to take a nap....

- Bruce Ballard, August 2014

Postscript: Learn a new word, and suddenly you see it everywhere. Here's a poem I came across in the *New Yorker* that I rather like.

Crepuscular

What a drubbing this sundown! – its gloom
hunting out my sorest remorse
to bludgeon me with. That's what the light does
in autumn, slanting southward and brownly
between the hunched houses of the neighborhood.
It falls against the sidewalk like a slab
of meat, like a mugging the passersby pass by.
The church bells bang hollow vespers.
Is there any sound more forsaken
than the rainbird smack across the spent grass?
Yes. The ignition jump of a car
heading anywhere, tail-lights red
as the rubber stamp on a divorce decree,
its diminishing rev a metaphor
for the failure of metaphor. The car
is a car leaving, then left.

- *Kimberly Johnson*

<http://www.newyorker.com/magazine/2011/01/03/crepuscular>