The Reason Why There Are Not More Lions is Natural Law

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An unexpected law of nature which keeps large predator numbers down across the spaces of the Earth and its oceans was uncovered this week by ecologist researchers at McGill University. McGill PhD student Ian Hatton wondered why there aren't more lions, when he started looking at the proportion of predators to prey across dozens of parks in East and Southern Africa. The answer had nothing to do with human hunters or safari expeditions.

Parks were chock full with potentially tasty treats for the lions, so you might think that the population of lions in each park would increase to match the available prey.

Instead, what Hatton and the McGill-led team stumbled upon was that, in a very systematic way, in crowded settings, prey reproduced less than they did in settings where their numbers were smaller. Not only that, but they found this same pattern in a whole range of different ecosystems.

This surprising finding suggests a level of organizational structure and function in ecosystems that had not been previously grasped.

Predator and prey communities exhibit a common but unexpected organizational structure.

Biologists have long known of very regular mathematical laws governing functions in the body like metabolism and growth, but no study has ever shown that similar kinds of laws may exist at a whole other level: that of ecosystems globally. Some scientists are already suggesting that it may well be the discovery of a new law of nature.

And it all came about by chance, says Hatton, the lead author of the study:

“I went to high school in Zimbabwe and spent vacations in the National parks there. When I began my PhD in biology at McGill, I wanted to go back and compare whole communities of African animals across protected ecosystems to see how the numbers of carnivores are related to their herbivore prey at the scale of whole landscapes. So I gathered all the animal census data I could for parks in east and southern Africa.”

When Hatton and his colleagues started analyzing data and crunching numbers, adding up all the carnivores (lion, hyena, leopard, etc.) and herbivores (buffalo, zebra, impala, etc.) in these parks, they found a very unexpected and regular pattern. In every park they looked at, there seemed to be a very consistent relationship of predator to prey.

But not in the simple pattern they might have expected to find.

“Until now, the assumption has been that when there is a lot more prey, you’d expect correspondingly more predators,” says Hatton. “But as we looked at the numbers, we discovered instead, that in the lushest ecosystems, no matter where they are in the world, the ratio of predators to their prey is greatly reduced. This is because with greater crowding, prey species have fewer offspring for every individual. In effect, the prey’s rates of reproduction are limited, which limits the abundance of predators.”

The researchers then analyzed data about food pyramids and relationship between predators and prey in ecosystems as varied as the Indian Ocean, the Canadian Arctic and the tropical rainforests. Over the course of the next few years they analyzed data gathered about both plants and animals from more than 1000 studies done over the past 50 years covering a range of grassland, lake, forest and ocean ecosystems around the world.

In all these different settings, they found a surprising consistency in the relation of predators to prey, and confirmation that rather than the numbers of predators increasing to match the available prey, predator populations are limited by the rate at which prey reproduce.

“The discovery of ecosystem-level scaling laws is particularly exciting,” adds co-author Michel Loreau, adjunct professor in McGill’s Biology Dept. and currently at the Centre national de recherché scientifique (CNRS) in France. “Their most intriguing aspect is that they recur across levels of organization, from individuals to ecosystems, and yet ecosystem-level scaling laws cannot be explained by their individual-level counterparts. It seems that some basic processes

reemerge across levels of organization, but we do not yet fully understand which ones and why."

The predator-prey power law: Biomass scaling across terrestrial and aquatic biomes

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