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Yearning to be Round:

A Primer in Ecological Concepts in 16 Parts

10. All Lives Seek Balance

All Lives are Self–Regulating

Inside and Outside must fit

**Lives regulate their internal conditions
to achieve Homeostasis and
Harmonize with their Environments**

**Biodiversity creates Flexibility in Ecosystems,
which allows them to maintain
a Dynamic Equilibrium**

A major principle of ecology is that living systems are self–regulating. Living systems must regulate their internal conditions to balance their interiors with their outside environments.

Maintaining a balance between a living system's internal conditions and fluctuating environmental (external) conditions is called **homeostasis.**

When this search for balance between inside and outside is successful, the living system continues to live.

When external changes (say of temperature) are too quick and too severe; balance cannot be maintained and the living system dies.

We are using the words "living system" rather than the simpler "organism" because this balancing act can be observed in living systems of any size, from single organisms to communities to ecosystems, to finally, the entire planet.

This reading will explore homeostasis (or balance–seeking) at three size scales.

- **First we'll look at homeostasis in individuals,**
- **second in ecological communities, and**
- **finally at homeostasis at the planetary level**

Homeostasis in Individuals

Homeostasis is the dynamic, continually adjusting equilibrium between the interior systems (sub-wholes) of an organism and its surroundings.

Another way to think of homeostasis is that living systems try to maintain a constant internal environment. The adjustments organisms make to keep their interiors stable or in a ‘steadystate’ are responses to the environment outside their bodies.

The most familiar regulation our own bodies do is temperature regulation. In humans, normal body temperature is about 98.1 F.

A rise in body temperature means we need to dump heat. We sweat and we breathe faster, two regulatory processes that lower the body temperature. To get rid of heat, we also reduce activity, and expand our capillaries so more blood can dump its heat near the surface of the skin. Our skin is an efficient heat–exchanger when the air around it is cooler than the body.

A decrease in body temperature, say from a chilly winter walk, leads to increased heat-producing activity such as the muscular contractions of shivering. Heat loss is also reduced by decreased circulation to the skin; the capillaries shrink.

From protozoans to worms to insects to mammals, the organ systems that get rid of unusable and excess substances work to maintain the balance between inside and outside.

The principal function of the excretory system of animals is homeostasis.

Most animals regulate the salt content of their internal fluids. The blood of most ocean fishes, for example is not nearly as salty as the ocean itself —if it were the fish would die. So marine fish must continuously adjust their blood to keep dissolved mineral salts out.

Freshwater fishes have the opposite problem: their blood requires a higher salt content than is found in fresh water. So they must continually regulate to retain dissolved mineral salts. In both cases, the kidneys accomplish this job.

Land animals regulate their temperatures; the salt and sugar content of their blood (fluid and electrolyte balance); and their metabolisms (energy production and use).

Homeostasis In Communities

Homeostasis is also the dynamic equilibrium among the individual members (sub-wholes) of an ecological community.

Attack–Avoidance as Homeostasis

We learned earlier that attack–avoidance behavior within a species often works as a dispersal agent, so that members of a population are evenly distributed over an area, so that competition for food is minimized.
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Attack–avoidance behavior also functions as a kind of social glue that creates social bonds and gives coherence to the social structure of a population.

Social aggression within a species is a homeostatic or regulatory process.

Homeostatic Responses to Overcrowding

When a population of mammals explodes its numbers for some reason, we discover an entirely different homeostatic process.

In many species, especially in small consumers such as mice, rabbits and lemmings, over–crowding by conspecifics (of their own species) creates a gradually increasing stress that damages the thyroid gland, which manufactures essential hormones.

When population densities reach a certain critical point, the stress becomes extreme and most of the population simply drops dead from endocrine (hormone) system damage.

In some species, such as snowshoe hares and lemmings, population density is cyclical and predictable.

Density gradually expands year after year—but before the environment is destroyed from overfeeding, this strange homeostatic process kicks in, most of them crawl into their dens and die, and the population problem is solved—until the next imbalance.

Lemmings are a small rodent that lives in the tundra north of the conifer forests of North America, Europe and Asia. When their population cycle peaks, their crowding–induced thyroid disease kills them so suddenly that their disappearance has given rise to stories that they have all flung themselves into the sea or migrated in the middle of the night.

The truth is that they are in their burrows, quite dead, which is even more strange than the stories people make up about their sudden disappearance.

Most natural populations never explode in numbers; if they do, it’s a good bet that human interference has removed a population control from the community.

When all the predators of deer (wolves, cougars, and so forth) are removed from a community, populations of deer explode.

Sometimes the homeostatic dispersal process works, and if there are places to go, the deer simply spread out. But of course, humans have allocated most space in the world to their own use, and when there are no places to go, crowded deer suffer from thyroid disease too, like the smaller animals.

Rats confined to the territories of other rats will die as the result of overproduction of hormones in response to their stress.

Captive crowded rats engage in all sorts of destructive stress behaviors, such as cannibalism and murder, which they don't normally do.

All of the normal social rules break down. This chaotic result of overcrowding is called a "behavioral sink."

What we really learn from studying animals in cages is that caged animals cannot behave naturally.

Homeostasis in Reproduction: Multiple Births

Another homeostatic process which regulates population is reproduction, specifically multiple births. In some species, such as whitetailed deer, crowding results in single births. When the same species is not crowded, twins are the rule.

Populations adjust themselves to “undercrowding” as well as to overcrowding.

Predation as Homeostasis

Predation can also be seen as a homeostatic process of communities. Predator/prey relationships have an odd element of cooperation in them.

Predators tend to kill the weakest members of the prey population, which include animals who are ill.

They do not kill the strongest and fastest prey, who survive to pass along those traits to their offspring.

Through natural selection, predation shapes the prey species as much as it shapes the predator. In brief, deer run fast because the slow ones were eaten.

So the conclusion is that predation helps regulate the health and stability of the community, both in the evolutionary long term, and the in short term.

Global Homeostasis

In Chapter 14, Biosphere, we discuss at length the planetwide regulation of conditions by life itself, and introduce the Gaia Theory, one attempt to explain global-level homeostasis.

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